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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... ... . 217, 238

TECHNICAL ARTICLES:

A New Method of Securing Traction on Heavy Grades (*illustrated*)..... 217
World's Columbian Exposition (*illustrated*)..... 218
Hoisting Machinery and Safety Clutches; Oils Elevating Cable Railway (*with inset, illustrated*)..... 220
State Management and Inspection of Railways in the Argentine republic..... 221
The Victoria Bridge, Stockton-on-Tees, England (*illustrated*)..... 222
Wear of Street Railway Track with Steam Motors (*illustrated*)..... 224
Water Towers in Massachusetts..... 225
London Sewage Disposal..... 226
Submarine Sentry and Sounding Machine (*illustrated*)..... 226
Filtering Plant "System, Fischer and Peters," at Worms, Germany (*illustrated*)..... 231
The Engineering Schools of the United States, XX..... 231
Sinking a Cylinder Pier with Screw Piles (*illustrated*)..... 233
Legal Decisions..... 234
The Chicago Union Transfer Railway (*illustrated*)..... 234
Cement Joints for Water Mains (*illustrated*..... 235
Chicago New Four-Mile Tunnel (*illustrated*)..... 236
A New Scraper for Boiler Tubes (*illustrated*)..... 237
Protection of Canal Banks in France and Holland (*illustrated*)..... 237

EDITORIAL NOTES 228

The Tilden Library—Bryant Park, New York, as a Site—A Solution of the Modern Labor Problem—The Van Zile System of Electric Traction.

EDITORIAL:

Wood as a Paving Material..... 229
Inventors and Buyers of their Inventions..... 229

LETTERS TO THE EDITOR..... 230

Pile Formulas and Wooden Beams—Wanted, a Porous Pan—A Question of Monuments—Fixing Street Grades (*illustrated*).

CONSTRUCTION NEWS..... 238-240

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

Breaks in water mains or accidents to pumping machinery affecting to a greater or less degree the water supplies furnished by five different water-works to seven cities and towns, all east of the Mississippi River, occurred during the five days, Aug. 27 to 31, inclusive. Perhaps the most serious break was in connection with the works at Newport, Ky., which also supply Bellevieu and Dayton, Ky., where early in the morning of Aug. 29, or on the previous night, the supply main broke about two miles from the city, cutting off the entire supply from the town for about 36 hours. Fortunately no fire occurred while the water was cut off, but it appears that the people had to shift for water for ordinary purposes as best they could, while some of the factories shut down. About 500,000 gallons of water was stored in 20 fire cisterns throughout the city, but these would afford only a slight fire protection for a city of more than 25,000 inhabitants. A connection with the Covington water-works had been suggested some time ago for use in just such an accident as this.

At Wilmington, Del., on Aug. 30, a schooner grounded on a 20-in. main laid beneath a creek to supply South Wilmington. For an hour the waste into the creek lowered the pressure in the main part of the city, but the shutting of a gate cut off the water from the break and restored the pressure in the larger part of the city. A small temporary pipe was at once proposed to furnish some water to South Wilmington and steps are being taken to repair the break.

At Atlantic City, N. J., on Aug. 31, the supply main from the mainland crippled the service of the Atlantic City Water Co., but it had a stand-pipe full of water which gave a partial supply until the break could be temporarily repaired. In addition the Consumers' Water Co. also supplies water in Atlantic City.

At East Liverpool, O., on Sept. 27, and at Macon, Ga., Sept. 29, the water service was rendered very deficient by accidents to the pumps. New pumps are being added at East Liverpool, but they could not be put in use until some two weeks after the accident, while to replace the injured part of the old pump some days were required. Fortunately but one side of this pump, a duplex, was rendered inoperative.

The moral to all the above tales is obvious, and, also the remedy for such difficulties, which has been pointed out in these columns in times past. Whenever duplicate mains or pumps are not provided, or else storage for several days supply, such accidents will leave cities without water. Fortunately no fires occurred in any of the seven communities mentioned above; but it was only by chance that they did not.

The average rate of wages in the United Kingdom, according to a late return made by the commercial department of the Board of Trade to the House of Commons, is as follows: Excluding the London police, with an average of $390 per annum, the annual rate of pay for England and Wales averages $345 in the large towns, and $370 in the small towns. The return includes 25,000 people engaged in work on roads, pavements and sewers, and the average rate of pay for these is $270 per year in the town districts and $180 in the rural districts. The statistics cover 5,000 people engaged about water-works, with an average annual pay of $325 in the large towns and $285 in the smaller towns. The full returns "relating to wages in the United Kingdom" have not yet appeared.

The Galveston, Tex., jetty work is thus reported upon by Major Charles J. Allen, Engineer-in-Charge: "One jetty 18,000 ft. long has been constructed and the railway trestle extended 428 ft. beyond the rock work up to June 30, 1890, under a contract which expired on that date. Since that date, under contract with O'Conner, Laing & Smoot, the following work has been done:

Completed jetty	4,600 lin. ft.
Jetty 6 ins. above M. L. T.	2,200 lin. ft.
Jetty 3 ft. above foundation	723 lin. ft.
	7,523 lin. ft.

Total length of south jetty since 1887..26,923 lin. ft.

Surveys made in May and June of this year show 13½ ft. in the outer bar channel, at mean low tide, and 21 ft. where the inner bar had been. The outer bar has increased slightly in width. On the date of Sept. 1, says the Galveston "Times," the complete and incomplete work amounted to 29,500 ft. This leaves 2,900 ft. between the present terminus and the present outer crest of the bar, taking the latter as 1,200 ft. wide. The present jetty is being built of rock dumped from a railway trestle, capped with 5 to 10 ton blocks of Texas granite placed by means of a floating derrick. The south jetty alone is being built, to be followed by one on the north if this does not give the 21 ft. of water required.

The Pennsylvania Railroad exhibit at the Columbian Exhibition is to cost between $60,000 and $70,000, and is in charge of General Superintendent T. N. Ely. The main exhibit will be on a plot of nearly 3 acres, and will include a section of 4-track road, laid with the new standard 100-lb. rail, in 60-ft. lengths, on the standard roadbed. On this track will be the latest locomotive built by the company and the first engine used, the "John Bull," now in the Smithsonian Institution. A station will be shown, with ticket office, waiting room, overhead bridge, etc. This station will be used for other exhibits of the company. Another separate exhibit will be placed in one of the Exposition buildings.

Railway economics was the subject of a paper read recently before the British Association by Mr. W. M. Acworth. His paper was entitled "A Plea for the Study of Railway Economics," and presented three questions of immediate practical importance, as follows: 1. The reduction of passenger fares, which was begun in Hungary, has extended to Austria, Holland, and France, and is expected in Germany ere long. How far does this afford a precedent for England? Reasons were suggested for thinking that Ireland might with advantage copy the Hungarian example, while in Great Britain such a course is out of the question. 2. The question of freight rates was commonly understood to have been finally settled by the recent adoption of new rates by the Board of Trade; but there is reason to believe, on the contrary, that it is only just beginning. There is great need for the guidance of trained economists with no personal interest to serve. 3. The construction of new railways, which are urgently needed, has been practically put a stop to by the extravagant standard of construction and working demanded by English public opinion. On the other hand, cheap railways were making very rapid progress in Holland, Belgium, Italy and elsewhere. Is it not possible that England had better have inferior railways in remote districts rather than none at all? As to the last matter mentioned, we should certainly reply in the affirmative, for reasons which were pointed out in our issue of July 14, in describing the new east and west coast railway. There is quite an extensive field yet for railways of economical construction and operation in England.

The most serious railway accident of the week occurred on Sept. 5, near Cranston's, N. Y., on the West Shore R. R. The locomotive of a north-bound express train was derailed, it is supposed by the breakage of some part of the machinery, while running at about 40 miles an hour. After striking a ledge of rock its course was diverted, and it plunged into the river and disappeared in 40 ft. of water. The mail and baggage car landed on top of the tender, and the forward end of the smoker also went into the river. The engineer and fireman were killed, and it is believed that five Italians who were stealing a ride on the front platform of the mail car went down with the wreck. Several trainmen and passengers were seriously injured.

A fast mail train on the New York Central & Hudson River R. R. ran into an open draw near New Hamburg, on Sept. 1, and the engineer, fireman and mail clerk were killed. The bridge was protected by danger signals, interlocked with the draw, so that the danger signal had to be displayed before the draw could be opened. The engineer disregarded the danger signal and did not apply the brakes until close to the draw. It was at this bridge that the terrible accident of Feb. 6, 1871, took place, in which 21 persons lost their lives. That accident, however, was not due to an open draw, but to the derailment upon the bridge of some oil cars in a down freight train, in such a manner as to block the up track.

An automatic tinning machine for tin plate manufacture has been developed by Norton Bros., of Chicago, and a manufactory has been erected at Maywood with floor space for 30 of these machines, which will be put in operation as fast as they can be built. As evidence of the success of these machines, it is stated that two of them have been ordered for a tin plate manufactory in Wales. Norton Bros. are still experimenting on a large scale with their process for rolling sheet metal direct from fluid steel, and have a 6-ton open-hearth steel furnace in operation.

Extras for work on the new four-mile tunnel for Chicago's water supply to the amount of $148,458 have been awarded to the contractor, Mr. Andrew Onderdonk, according to reports. The total of his claim was $363,340. The award was made by the Council Finance Committee after hearing expert testimony. It appears that the claims for extras were made on the ground of unexpected difficulties met in construction.

The new compound locomotive for the Pennsylvania R. R., which is being built at the Altoona shops from designs by the Motive Power Department, is to have 7-ft. drivers. This is 6 ins. larger than the drivers of the fast express locomotives on the New York Central and on the Central R. R. of New Jersey, indicator diagrams from which were given in our issue of June 9. We believe, however, that the New York Central is now building a 7-ft. driver locomotive.

The Krag-Jorgensen magazine gun, recommended for use in the U. S. Army by the Board of Experts appointed by the War Department, is a modification of the arm invented by Carl Krag, superintendent of the royal manufactory of arms at Koenigsberg, Norway. The original gun is 4.35 ft. long; weighs 9.4 lbs.; has 6 grooves with one turn in 11.8 ins.; the bullet weighs 237.6 grs. and is credited with an initial velocity of 2,000 ft. per second. The gun recommended has a .30-in. caliber, which is slightly smaller than the Norwegian gun. The magazine carries five cartridges, but the weapon can be used as a single-loader. The barrel is covered with a metal casing ⅜ in. thick to enable handling in rapid firing. To this casing a knife-bayonet is attached.

Litho-carbon, says "Iron," is a new mineral somewhat resembling asphalt. It is claimed that it is a perfect insulator; that as a paint it will resist heat and acids of all kinds; it possesses the power of entering the pores of iron and steel, rendering these metals impervious to acids, and that it can be rolled into tissue, leather, wood-pulp, etc., and makes these substances water proof without imparting odor. On ships' plates it will prevent the adherence of barnacles, etc. What this really wonderful mineral is, or where it comes from, "Iron" does not say.

Those concerned in ship or boat railway schemes, or in drydock construction, should notice a recent American patent (No. 481,405) issued to Mr. Walter R. Kinipple, M. Inst. C. E. The inventor proposes to support the ship in the cradle by "hydraulic cushions" having pressure regulating attachments, and has been granted a broad claim for the use of such cushions between the ship and its supports. The specification, however, sheds no light on the important question as to what material, at once flexible and durable, the inventor would propose to use for his hydraulic cushions.

New processes of steel making seem to be "all the go" in the South. Mr. Benj. Talbot, Superintendent of the Southern Iron Co., of Chattanooga, is said to have developed a process of desiliconizing molten iron by filtering it through a molten basic slag, thus preparing it for treatment in the basic furnace or converter in the ordinary way. An invention of more mysterious character is attributed to a Mr. Hastings, of Chattanooga, and is said to have been tested with satisfactory results at the East Birmingham Foundry & Machine Works. The inventor merely puts certain "ingredients" into the molten cast iron and treats it either in the puddling or the open-hearth furnace, the product is said to be a first class quality of steel and may be made of any desired hardness according to the "ingredients."

A NEW METHOD OF SECURING TRACTION ON HEAVY GRADES.

The device illustrated herewith is intended especially for electric railways which have to operate on heavy grades; but there is reason to believe that it may be used to advantage on certain classes of steam railways as well. The operation of the device is evident from Fig. 1. A friction rail is placed in the center of the track and securely spiked. The traction wheels to which the power is applied are mounted on one end of arms the other ends of which are pivoted to the car body. If the car in Fig. 1 is being driven in the direction of the arrow, the tractive force exerted presses the traction wheels against the central rail with a force which increases as the tractive force increases, so that slipping is impossible

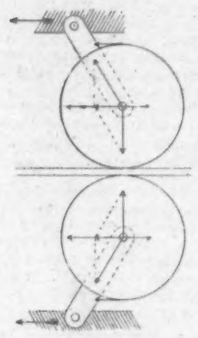


Fig. 1.

DIAGRAM OF TRACTION DEVICE.

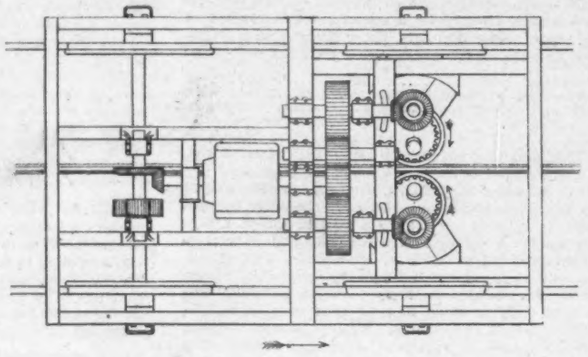


Fig. 3.

PLAN OF TRUCK AND MOTOR OF VAN ZILE'S TRACTION CAR.

no matter how steep the grade. By this means great weight in the motive car is not essential, and a light motor car will haul trail cars up as steep a grade as the motor has power to overcome.

The traction wheels are kept against the central rail by a light spring which gives them a sufficient initial grip on the rail to prevent slipping at the start and enables them to exert a tractive force upon the car. As soon as this tractive force comes into play the pressure of the wheels on the rails is increased to a point where slipping is impossible.

Of course the relation between the pressure of the wheels on the rail and the tractive force exerted depends upon the angle which the pivoted arms make with a perpendicular to the rail. It may easily be shown that theoretically (omitting the initial pressure due to the spring) the friction between the wheel and the rail will just equal the tractive force when the angle between the arm and the perpendicular to the rail equals the angle of friction. In practice the arm is set at an angle small enough to provide sufficient traction when the rails are in the most slippery condition.

It will be seen that what applies to the motor is true also of the brakes, and that any grade may be descended in safety so long as the central rail holds to its fastenings, any increase in the brake pressures being at once followed by a harder grip on the rail. This is a feature of much importance.

The most important limitation which we notice to the application of the principle in traction is that with a single pair of wheels grades in one direction only can be mounted or descended. By having two pairs of traction wheels inclined in opposite directions, or by having the arms on which a single pair are mounted arranged to revolve and incline in the opposite direction, this difficulty might be overcome; but either plan would involve additional complexity and cost. The application of this invention which at present seems most obvious, however, is to the operation of single heavy grades on electric railways, where one or two motor cars fitted with this device would constantly operate, pushing up and taking down the regular cars on the line. As the incline would generally be in one direction only, a single pair of traction wheels on a motor would in this case be sufficient. An incidental advantage of this plan of operation over the ordinary method is that one or two picked men may be selected for operating the e helper motors on heavy grades and the traffic may be carried more safely over these dangerous places than if it were entrusted to the ordinary run of motor men.

The design of a truck and motor to operate on the principle outlined above was a matter of considerable difficulty. In the first machine built the motor was mounted on the rear axle and drove bevel gears by a chain and sprocket wheel connection which meshed with bevel gears on the faces of the traction wheels. This machine was tested on grades of 5%, 15% and 30%, and in the presence of a number of street railway men was made to ascend these grades and stop at any point. It was also shown to be under perfect control in descending these grades. The accompanying cut is reproduced from a photograph of the car standing on the 30% grade.

The sprocket wheel and chain method of transmitting power from the motors to the driving wheels was only used for the experimental car; and in a new car now building, the driving gear of which is illustrated in Fig. 3, the chains have been dispensed with. The motor is mounted with its shaft lengthwise of the car, and by moving a clutch may be made to drive either the rear axle by bevel gearing or the chain of gearing connected with the traction wheels. The truck is so arranged that inequalities of the center rail will not interfere with the proper working of the gearing.

It is believed that this system of traction may also be made applicable to steam motors for use on heavy grades or on elevated roads where the weight of the motor necessary to haul long trains by the present system is a serious objection. In comparison with the rack rail system, which is coming into such extensive use on heavy grades, it would have the great advantage that the traction rail would be much cheaper and more durable.

The inventor of this novel system of traction is Mr. H. L. Van Zile, C. E., of Albany, N. Y. It is interesting to note that Mr. Van Zile's first designs for a traction device on this principle were made in connection with his graduating thesis while a student in college.

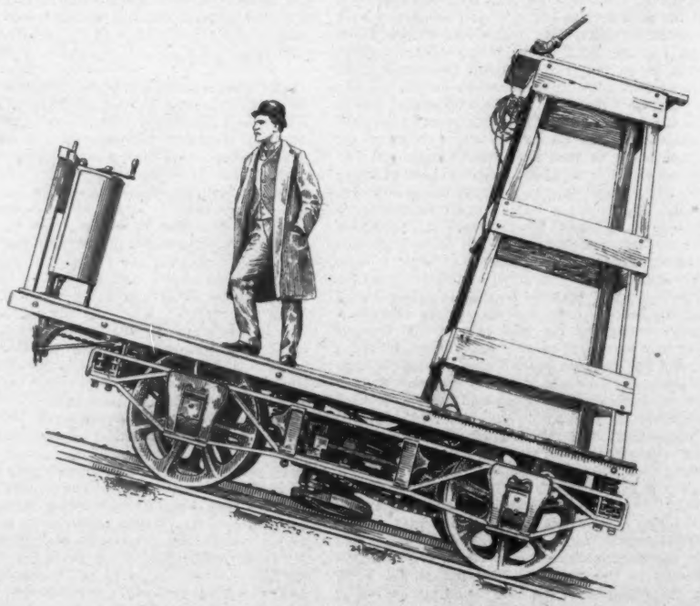


FIG. 2. EXPERIMENTAL CAR FITTED WITH VAN ZILE'S TRACTION DEVICE, STANDING ON 30% GRADE.

WORLD'S COLUMBIAN EXPOSITION.

Manufactures Building.

The construction of this great building was described and illustrated in our issue of Sept. 1, and we illustrate this week the trussed purlins which connect the arched roof trusses and carry the trussed rafters which in their turn carry the wooden jack rafters 4 × 6 ins. Purlins A are 50 ft. span, and purlins B 73 ft. 6 ins. span, connecting the two middle pairs of roof trusses. The Mines and Mining Building has trussed purlins 64 ft. 6 ins. long, as described in our issue of May 15, and the Machinery Building has trussed purlins 50 ft. 8 ins. and 52 ft. 2 ins. long, as described in our issue of June 30.

Department of Liberal Arts.

The Department of Liberal Arts will occupy about 400,000 sq. ft. of space in the south end of the Manufactures' Building, and this department includes the group of Engineering and Architecture. The amount of space given to this department at this and previous expositions is as follows:

Philadelphia, 1876	35,782 sq. ft.
Paris, 1878	111,000 sq. ft.
Paris, 1889	244,000 sq. ft.
Chicago, 1893	400,000 sq. ft.

At Paris in 1889, a separate building, 738 × 275 ft. was assigned to Liberal Arts, having an area, including galleries, etc., of 304,300 sq. ft. but a large portion of the building was occupied by cafes, miscellaneous exhibits of foreign countries, and by the groups of archaeology and ethnology. Of the 400,000 sq. ft. at Chicago, 200,000 sq. ft. will be upon the ground floor. There will be no motive power or processes of manufacture in this building. Mr. Selim H. Peabody is Chief of the Department of Arts.

The reception of exhibits will commence Nov. 1, 1892, and no article will be admitted after April 10, 1893. No fire, inflammable oils or other combustible material will be permitted in the building, and no machinery will be installed, but a limited amount of noiseless motive power may be applied. The official designation is Department L, Liberal Arts: Education, Literature, Engineering, Public Works, Music and the Drama. It is divided into twelve groups, and subdivided into 115 classes. The following is an abstract of the classification:

Group 147. Physical Development, Training and Condition; Hygiene.—Dwellings and buildings; public baths. Sanitation. Heating and ventilating. Drains and sewers; plumbing. Sewage and garbage disposal. Water purifying and filtering. Prevention

of infectious diseases. Sanitary appliances in buildings, factories, mines, etc. Building regulations and inspection.

Group 148. Instruments and apparatus of Medicine, Surgery and Prosthesis.—Including vehicles and appliances for the transportation of sick and wounded.

Group 149. Primary, Secondary and Superior Education.

Group 150. Literature, Books, Libraries and Journalism.—Including topographical maps, marine and coast charts; geological, meteorological, physical and other maps; relief maps, profiles of ocean beds and submarine cable routes; railway maps.

Group 151. Instruments of Precision, Experiment, Research and Photography; Photographs.—Weights and measures; balances; cash registers, calculating machines, graduated scales; water and gas meters. Astronomical instruments. Geodetic and surveying instruments. Transits, theodolites, compasses, mine instruments, plane tables, quadrants, sextants. Leveling instruments. Hydrographic surveying, and deep sea soundings. Thermometers, barometers, rain gages and other meteorological instruments. Clocks and watches. Optical and acoustic apparatus.

Group 152. Civil Engineering, Public Works, Constructive Architecture.—Land surveying, topographical surveying.—Surveys and locations of towns and cities, with systems of water supply and drainage. Surveys of coasts, rivers, and harbors. Construction and maintenance of roads, streets, pavements, etc. Bridge engineering, illustrated by drawings and models. Bridge designing, drawings and charts, showing methods of calculating stresses. Foundations, piers, abutments and approaches of stone, wood, etc. Arch bridges of stone, wood or iron. Suspension bridges of fiber, iron chain, and cable. Truss bridges of wood, iron and steel; pony, bow-string and plate girders, lattice girders, Fink, Bollman, Howe, Pratt, Warren, Post, Long, Whipple and other trusses of special design. Cantilever bridges, drawbridges, rolling and swinging machinery. Tubular bridges. Railway aqueduct, and other bridges of special design not elsewhere classed. (A chart showing date of completion, span, rise, weight, and cost of the great bridges of the world, would be of interest.)

Subaqueous constructions;—Foundations, piers, harbors, break-waters, dams, water-works and canals. Irrigation; irrigating canals and systems. Railway engineering; surveying, locating and constructing railways.

Dynamic and industrial engineering; the construction and working of machines; examples of planning and construction of manufacturing and metallurgical establishments. Mine engineering; surveying underground, construction of tunnels, subaqueous tunnels, etc.; locating and sinking shafts, inclines, and winzes; driving levels, draining, ventilating, and lighting. Military engineering; construction of earthworks, breast-works and temporary fortifications. Permanent works; fortifications, magazines, arsenals, and mines. Roads, bridges, pontoons, etc.; movement of troops and supplies.

Constructive architecture.—Plans of public buildings for special purposes; large and small dwelling houses. Drawings and specifications for foundations, walls, partitions, floors, roofs, and stairways. Estimates of amount and cost of material. Designs and models of special contrivances for safety, comfort and convenience in the manipulation of elevators, doors, windows, etc. Working plans for the mason, carpenter and painter; designs and models of bonds, arches, coping, vaulting, etc.; plastering and construction of partitions; painting and glazing.

Plans of appliances for hoisting, handling and delivering building materials to artisans; scaffolding and ladders, special scaffolding for handling great weights; portable cranes and power elevators. Illustrations of the strength of materials. Plans and sections of special architectural forms. Metallic floor beams and girders; hollow bricks and other architectural pottery for heating and ventilation; metallic cornice and conduits, shingles and sheathing, glass roofs, floors and accessories, architectural hardware. Methods of combining materials. Protection of foundations, areas and walls against water. Working plans for paving and draining.

Group 153. Government and Law.—Postal systems and appliances. Police stations. Prisons and reformatories. Convict management.

Group 154. Commerce, Trade and Banking.—Railways and transportation companies. Money and methods of exchange. Counting houses and fittings. Warehouse and storage systems. Grain elevators. Insurance and banking companies. Safes and vaults. Bookkeeping. Express companies, freighting, etc.

Group 155. Institutions and Organizations for the Increase and Diffusion of Knowledge.—Scientific institutions; academies of science and letters, museums, art galleries and exhibitions, state and national exhibitions. Libraries, public and private.

Group 156. Social, Industrial and Co-operative Associations.

Group 157. Religious Organizations and Systems; Statistics and Publications.

Group 158. Music and Musical Instruments. The Theater.

Department of Manufactures.

This department, as already noted, will occupy the same building as the Department of Liberal Arts, and will have a very wide and comprehensive scope. About 50 foreign countries and colonies have signified their intention to make exhibits. It is not intended that machinery shall be installed, but shall be placed in the Machinery Building. In order to encourage pleasing and attractive effects and add life to the various exhibits, where required to keep them moving, a limited amount of noiseless motive power may be applied, subject to approval. No single piece of any exhibit weighing over 30,000 lbs. will be accepted, if machinery is required for its installation.—Mr. James Allison is Chief of the Department of Manufactures, which is officially designated as Department H, Manufactures, and is divided into 34 groups and 214 classes. The following is an abstract of the classification:

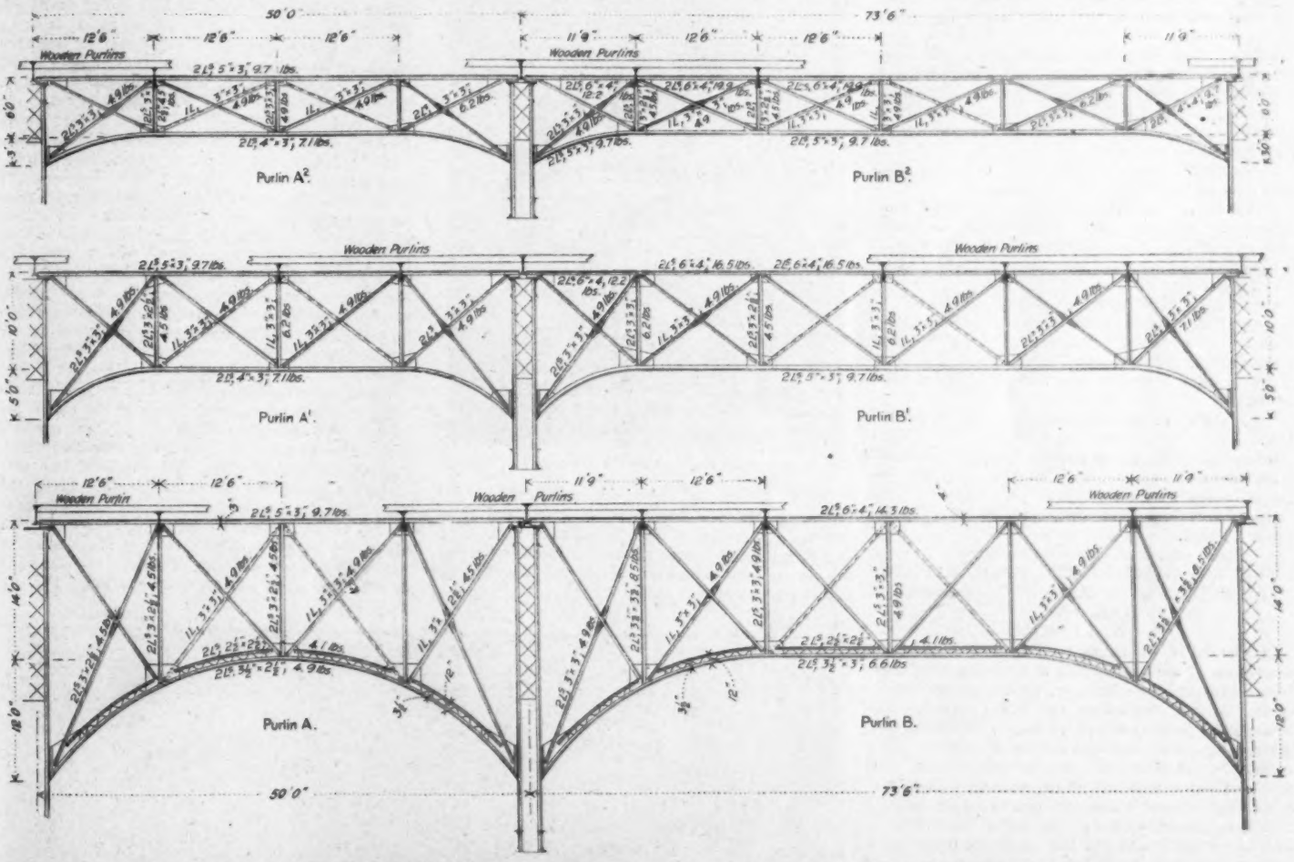
Group 87. Chemical and Parmaceutical Products; Druggists' Supplies.

Group 88. Paints, Colors, Dyes and Varnishes.

Group 89. Typewriters, Paper, Blank Books, Stationery.

Group 90. Furniture of Interiors; Upholstery and Artistic Decoration.—Including floors, ceilings, walls, doors and windows.

Group 91. Ceramics and Mosaics.—Bricks and terra cotta; tiles; tile and mosaic pavements.



PURLINS IN ROOF OF MANUFACTURES AND LIBERAL ARTS BUILDING, WORLD'S COLUMBIAN EXPOSITION.

Group 92. Marble, Stone and Metal Monuments, Mausoleums and Mantels; Coffins and Undertaker's goods.
Group 93. Art Metal Work, Enamels.
Group 94. Glass and Glassware.
Group 95. Stained Glass in Decoration.
Group 96. Carvings in Various Materials.
Group 97. Gold and Silver Ware, Plate, Etc.
Group 98. Jewelry and Ornaments.
Group 99. Horology; Watches and Clocks.—Including watchmens' time registers.
Group 100. Silk and Silk Fabrics.
Group 101. Fabric of Jute, Ramie and Other Vegetable and Mineral Fibers.
Group 102. Yarns and Woven Goods of Cotton, Linen and Other Vegetable Fibers.
Group 103. Woven and Felted Goods of Wool and Mixtures of Wool.
Group 104. Clothing and Costumes.
Group 105. Furs and Fur Clothing.
Group 106. Laces, Embroideries, Fans.
Group 107. Hair Work, Coiffures and Toilet Accessories.
Group 108. Traveling Equipment, Valises, Trunks, Toilet Cases, Canes and Umbrellas.
Group 109. Rubber Goods, Celluloid and Zylonite.
Group 110. Toys and Fancy Articles.
Group 111. Leather and Manufactures of Leather.
Group 112. Scales, Weights and Measures (See also Group 151, Liberal Arts.)
Group 113. Material of War; Ordnance and Ammunition. Military and Sporting Small-Arms. Weapons and Apparatus of Hunting and Trapping.
Group 114. Lighting Apparatus and Appliances.—Oil, gas and electric lamps and fixtures.
Group 115. Heating and Cooking Apparatus.
Group 116. Refrigerators, Tinware and Enameled Ware.
Group 117. Wire Goods.
Group 118. Wrought Iron and Thin Metal Exhibits.
Group 119. Vaults, Safes, Edge Tools and Cutlery.
Group 120. Plumbing and Sanitary Materials.—Bath tubs and water closets; flush tanks, plumbers' and gasfitters' hardware.
Group 121. Miscellaneous Articles Not Elsewhere Classed.

HOISTING MACHINERY AND SAFETY CLUTCHES; OTIS ELEVATING CABLE RAILWAY.

(With inset.)

In our issue of Aug. 18 we gave a general description of the construction and equipment of the Otis Elevating Cable Railway, up the eastern slope of the Catskill Mountains, and called attention to some of the peculiarities of its design. We show in the accompanying cuts and on our inset sheet this week some general photographic views of the incline and complete details of the hoisting machinery and safety devices, which are used in its operation. It will be remembered that the incline is 7,000 ft. long along the grade and has a rise of 1,630 ft., with a maximum grade of 34%. Fig. 1 gives a general view of the line from a point near its bottom and shows very clearly the construction of that portion of the track laid with ballast in the ordinary manner. In Fig. 2 is shown a portion of the long trestle, detail drawings of which were given in the previous article.

With regard to the hoisting machinery there is little to be said in addition to the description given in the first article which is not plainly shown by the drawings. In general it does not vary materially from that in use on other cable inclines except, perhaps, in its magnitude and the unusual precautions taken to insure safety in operating the road. It is located at the top of the incline and consists in brief of two Hamilton-Corliss, reversing engines, with 12×30 in. cylinders, driving a single shaft which is geared to two spur wheels operating the drum shaft and winding drums. The foundation is of brick and stone masonry on solid rock. The winding drums are 12 ft. in diameter and are provided with six grooves for the cables and also with seats for friction brakes, which are to be connected with a suitable mechanism for throwing them into operation should the car overrun its proper position at the station. In addition to the brakes on the drums there are also friction brakes on the engine shaft which are operated by one of the levers in the operating tower.

As noted in the previous article, the machinery

Fig. 1. General View of Otis Elevating Ry.; Catskill Mts., N. Y.

is operated from a tower directly above and from which a clear view of the whole line is had. This is accomplished by three systems of levers operating the steam and reversing valves and the friction brakes on the engine shaft.

It will be seen that with the exception of the automatic stop the operating of the safety devices connected with the hoisting machinery is in the hands of the operator. To provide against accident, should the operator become careless, or incapacitated for any cause, or should the hauling cables break or stretch, safety clutches are attached to each passenger car. These clutches are designed to work either when one cable breaks or stretches unduly or when the car exceeds a certain fixed rate of speed. Details of the clutches are shown in Figs. 7—11, on the inset sheet. They were designed by Mr. Thos. E. Brown, Jr., M. Am. Soc. C. E. (to whom we are indebted for the blue prints, from which our drawings are made), and are used for the first time on this line.

The operation of the clutches is as follows: Each set of two cables after passing through guides is fastened by open sockets to the drawbars which bear against the levers B, B, shown in Figs. 7 and 10. These levers swing upon the shaft E and bear in turn against the frame D, which is keyed to the shaft E, and also against the double pivoted plate, or disk A. Should one of the cables break or stretch sufficiently to about double the strain on the other, the disk A revolves around one of the pivots through an angle limited by the curved slots C, C, and the lever B, or B, attached to the unbroken cable, swings forward moving the frame D, and causing the shaft E to make a partial revolution. This causes the lever arm F, which is keyed to the shaft and abuts against the spring G, to swing forward, thus compressing the spring G, and causing a pull on the rod H, which is connected with the long arm of the bell crank I. The bell crank I is connected by the rod J to a second bell crank K (Fig. 9), which presses against the jaw L of the clutch, bringing it into contact with the wooden guard rail. The movement of the jaw L, by means of a system of levers, brings the other jaw of the clutch into contact with the rail and the friction causes the clutch to swing back toward the frame T, bringing the teeth into such a position that any forward motion of the car increases the grip of the clutch.

When the fixed rate of speed exceeds a certain limit, 12 miles per hour, the jaws of the clutch are thrown into action by an entirely different mechanism, which is actuated by an Otis wheel governor, shown in elevation at M. No details of this governor are given, but its construction is exactly the same as the governor used with the Otis elevators in the Eiffel Tower, an elevation and section of which are shown in Figs. 3 and 4. It consists of two toothed weights shown in section at A, A. and in elevation at A', A', (N, N, on inset Fig. 7).

FIG. 2 VIEW OF LONG TRESTLE; OTIS ELEVATING RY.

Each of these weights is fastened to arms of two bell crank B, B, the other arms of which are pivoted to the sliding rods C, surrounded by spiral springs D. When the revolutions of the wheels ex-

ceed a certain number per minute, the weights tend to fly apart under the influence of centrifugal force, this motion being allowed by the bell cranks and springs as plainly shown in the figures.

Turning now to the operation of the clutch, Figs. 7 and 8, it will be seen that as the weights N, N, fly apart their teeth come in contact with the trigger O, fastened to one end of a rocking shaft to the other end of which is attached a short arm P, which locks with the nut Q on the rod R, and holds in compression the spring S. When the teeth of the weights strike the trigger the rocking shaft makes a partial rovolution, lifting the arm P, and releasing the spring S. This expands and presses the rod R against the long arm of the bell crank I. This pressure is transmitted to the mechanism of the clutch, causing it to operate in the manner already described.

The whole mechanism is very ingenious and all tests, both in the shops and on the cars, have shown its operation to be effective. It would seem, however, as if the construction lay open to the charge of unnecessary complexity. The fewer parts such a mechanism has and the simpler these parts are put together the better, generally speaking.

The contractors for the construction and equipment of the road proper were given in our issue of Aug. 18. The contractors for the engines and hoisting machinery were the Walker Mfg. Co., of Cleveland, O., to whom we are indebted for the drawings of that machinery shown on the inset. The safety clutches were manufactured by Otis Bros. & Co., of New York City.

"Da," a word sometimes heard in connection with textile material, is an annual found in Western Africa, and bearing a considerable resemblance to European hemp. It is now cultivated in small quantities by the natives and used in making threads and strings. The plant belongs to the family of the malvaceae, and when the dry stalk is rubbed very long threads are produced resembling hemp in color and texture.

STATE MANAGEMENT AND INSPECTION OF RAILWAYS IN THE ARGENTINE REPUBLIC.

It is an admitted fact that while government supervision and control of railways may be desirable in order to increase the safety and convenience of operation, government ownership of railways in other countries has never yet risen to the standard of excellence in any important respect which private companies afford in America and England. What conclusions could be drawn from this fact, whether it condemns government management in the abstract, or results only from differences in national characteristics is a disputed point. Certain it is, however, that, the British Australian Colonies, in all but one of which the railways are owned and operated by the government, the service is anything but good or efficient and this is one of the strongest proofs that government management as such must tend to inefficiency.

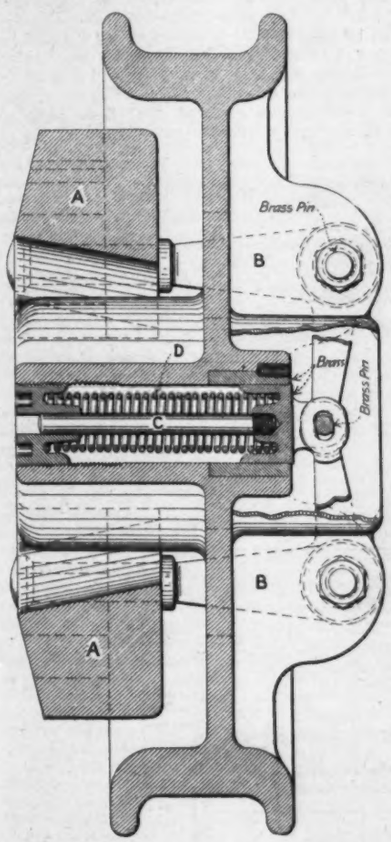
That bad results are following from governmental management the case in the Argentine Republic, where some of the railways are under government management, and others under the management of companies, but where all are subject to government inspection, is shown by an article on the "River Plate Railway News," of Buenos Aires, which says:

The "Prensa" in a recent issue discusses the scandals which have become chronic on the State lines in the northern provinces of the republic, and expresses disappointment that the regulation of a comparatively short line should paralyze the efforts of the Railway Department to which that administration is intrusted. It is suggested that disagreement between the members of the Direction of Railways may be the reason why no measures are taken to remedy the unsatisfactory conditions which prevail on the railways under the management of the department in question. This may or may not be the case, but we prefer to attribute the inactivity of the department to incapacity rather than to personal motives. The persons on whom the onus of the scandal rests, are precisely the members of the Direction of Railways, and they ought to be held responsible for the results their maladministration has brought about.

The continuous scandals in connection with the state railways are arguments far more effective than any which we can adduce in deprecation of the tendency in official circles to increase the power and influence of the department to which the control of the railways is committed. It is impossible not to recognize that the department is not simply useless to the country, but actively mischievous, and we are certain the Railway Department has done more to popularize Argentine discredit abroad than any other institution in the country. It was fondly supposed abroad, before the Direction of Railways thrust itself into special prominence, that the proprietors of private railway companies had the security of the unincumbered railway properties which had been constructed with their investments. The Railway Board has dispelled this illusion and taught investors that, given a sufficiently inefficient and unscrupulous railway department, their properties can be reduced to ruin with as much facility as the state lines.

In another issue the "Railway News" refers more directly to the trouble due to state management on the railway above referred to:

A commission of investigation has recently completed an examination into the affairs of the North Central State Railway, and it would seem that the accounts of the railway are absolutely worthless. The railway laws and official regulations seem to have been entirely disregarded, and the whole business appears to be in the most complete confusion. The same state of affairs appears to recur periodically, and the usual practice is to put in a new set of employees and let things take their chance for a few months, when the whole performance has to be gone through afresh. The entire strength and talent of the Direction General of Railways is quite unequal to the task of bringing these four or five hundred miles of railway into anything distinctly resembling regularity. We cannot conceive a more complete exhibition of inaptitude than is displayed in the efforts of this government department to regulate the affairs of these insignificant lines. Nevertheless, the same body is intrusted with practically arbitrary power over the guaranteed railways, and with considerable authority upon non-guaranteed lines.



Section L, M, N, O, P, Q

Fig. 3.

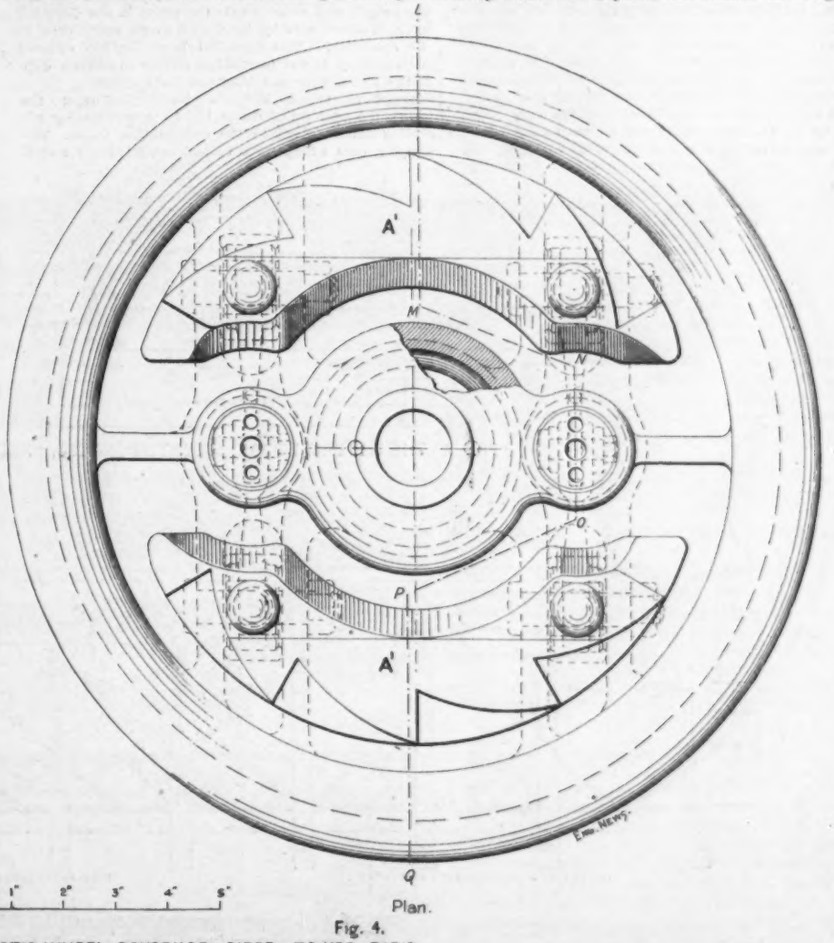


Fig. 4.

OTIS WHEEL GOVERNOR; EIFFEL TOWER, PARIS.

It seems almost incredible that such conditions should be permitted to exist, but they do.

A feature of the government control of the railways, however, which is worthy of careful consideration, is that of the regular inspection of the several lines by government officials. These inspections are made monthly, and below we give a few examples of the monthly reports made by the inspectors, as taken from the official report for May, 1892. It will be noticed that the reports cover construction and maintenance, rolling stock, equipment, train service, station accommodation, and questions relating to rates, and they are made public at once.

Buenos Aires & Rosario Railway.—The running of trains has been regular during the month, and level crossing barriers have been properly attended to. The cleanliness of the first class cars is very deficient owing to the little care taking to clean out the dust at the depot stations such as Galvez and others. This negligence has been brought to the notice of the company. The transhipment of baggage and parcels still continues at Galvez station, notwithstanding the instructions given by the Government Inspector that it must cease. The condition of the line and earthworks is good. On May 20 a derailment of little importance occurred at Sanchez station.

Buenos Aires & Pacific Railway.—The train service during the month has been regular. The lighting of passenger cars with kerosene is bad, and the Railway Department has authorized its inspector to exact peremptorily from the company within 15 days the complete disuse of kerosene. The inspector has also been instructed to indicate to the manager the necessity of placing at Villa Mercedes, the junction with the Transandine line, timetables of the combination trains. Also the necessity and convenience to the public service and in the interest of the company itself, that this station should connect its telegraph lines with those of the Transandine and Argentine Great Western railways. This line, as well as that from Mercedes to Rufino, is in good condition, with the exception of a few "slacks" of no importance.

Central Cordoba Railway.—The track is in fair condition, and during the month ballast trains have been working. Ties have had to be renewed between Lamadrid and Tucuman. This railway requires the renewal of 30,000 ties. It has been ordered that at present 10,000 only shall be renewed, and renewals be continued by sections till the whole line is in good order. On the earthworks of the river Valderrama a special gang is at work surfacing the track. On the Santiago branch at kilom. 143, there is a side track for wagons with wood for a sugar mill. This side track has but one switch, and consequently the trains in one direction have to shunt cars by hand and waste much time in the operation. The technical inspector has ordered the company to put in another switch to obviate difficulties and danger in taking and leaving cars.

Argentine Great Western Railway.—During the month the running of trains has been satisfactory excepting small delays to the combination trains. The sleeping cars which were in bad condition are undergoing repairs and will be ready for use shortly. The fencing is not good but will be improved as soon as possible. The buffet so necessary at San Juan station will shortly be opened. Petitions are constantly presented by merchants asking for special rates for certain articles. The petitions should be decided as soon as possible for the encouragement of trade and industries of the district.

Transandine Railway.—The service of this line during the month has been fairly good, though passengers complain of the want of heating apparatus in the cars.

This might be an excellent system for securing safety and efficiency in operation, especially in the moral effect of the publicity which it gives to the good management or the shortcomings of the various railways. If that system of inspection were carried out in the impartial and thorough way of the British railway accident investigations, it might do much good, but so far as we can gather this is very far from being the case.

THE VICTORIA BRIDGE AT STOCKTON-ON-TEES, ENGLAND.

We give below an abstract of a paper by Mr. Charles Neate, M. Inst. C. E., presented to the Institution of Civil Engineers, describing a new bridge built under his supervision, the foundations of which involved some interesting work. The Victoria bridge was built to replace an old stone bridge with five arches, the middle one being 50 ft. span. This bridge was built about 1770, and was 21 ft. wide, with one sidewalk. About 1862 the parapet and sidewalk was removed, the whole width of 21 ft. appropriated for the roadway, and a 4½ ft. sidewalk built on iron brackets on each side. Evidence of weakness of the foundations and sidewalks appeared later, and in 1881 a bill was passed by Parliament authorizing the construction of a new bridge. Mr. Neate and Mr. Harrison Hayter were joint engineers. The bridge has a center span of 110 ft. and two spans of 85 ft., with a land arch 12 ft. wide in each abutment. The roadway is 40 ft. wide, with two sidewalks 10 ft. wide. The grade of the roadway is 1.66%. The length over abutments is about 400 ft. The crown of the center

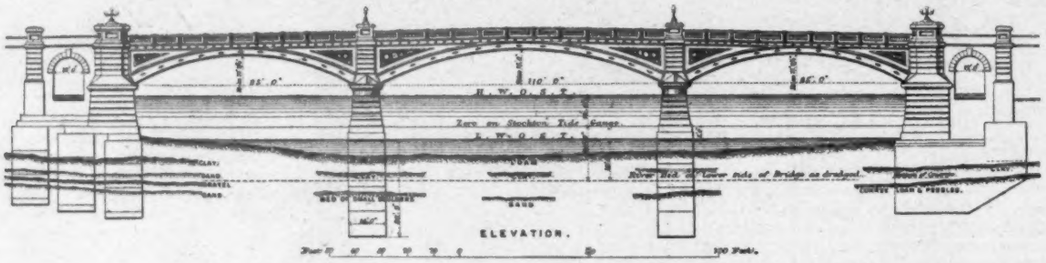


FIG. 1. THE VICTORIA BRIDGE, STOCKTON-ON-TEES, ENGLAND.

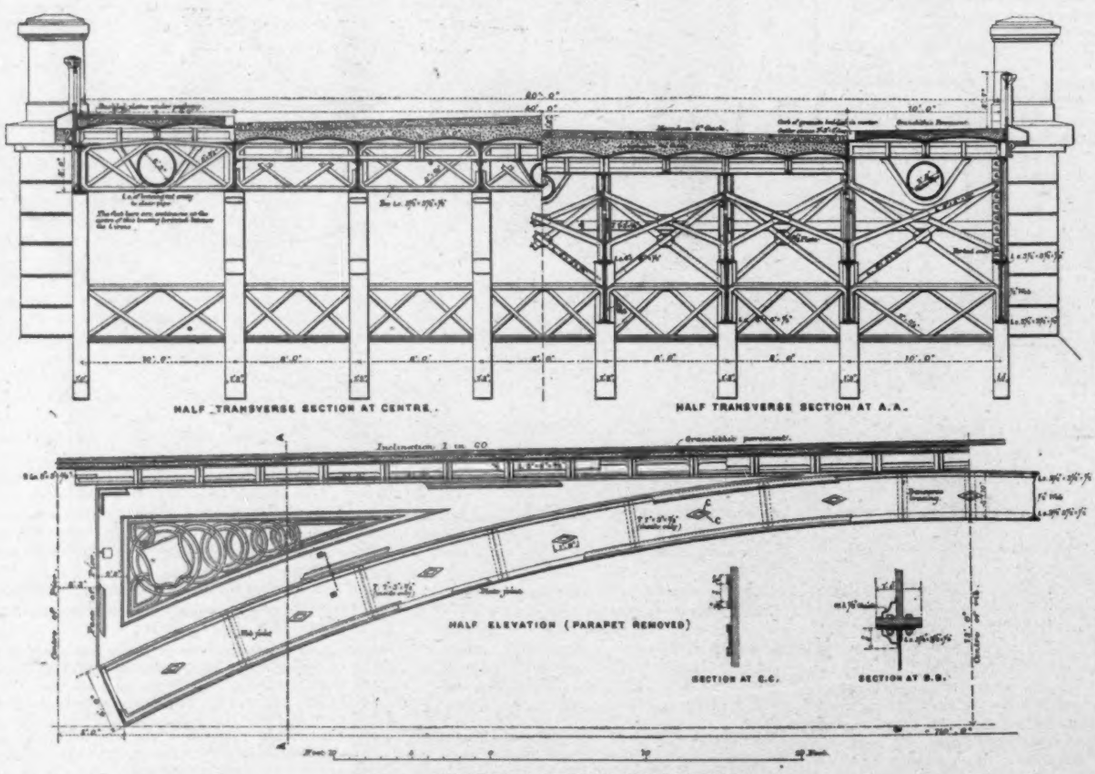
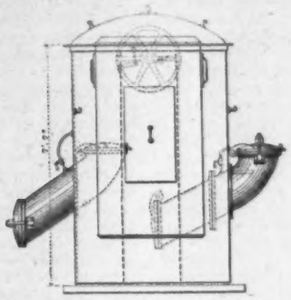

HALF TRANSVERSE SECTION AT CENTRE.
HALF TRANSVERSE SECTION AT A.A.
HALF ELEVATION (PARAPET REMOVED)
SECTION AT C.C.
SECTION AT B.B.

FIG. 2. SUPERSTRUCTURE, VICTORIA BRIDGE.

arch is 18 ft. and those of the side arches 16 ft. 3½ ins. above high water at spring tides. The elevation of the bridge is shown in Fig 1, and the cross-section



in Fig. 2. Mr. Neate then proceeds with the details of the bridge as follows:

The abutments and piers are built in stone masonry, the facework being of coursed ashlar. Each pier is founded upon five cylinders of cast iron 14 ft. diameter, with a bottom ring of wrought iron, all filled with cement concrete. The abutments were to have been founded upon beds of cement concrete, surrounded by tongued and grooved sheet piling, but this was altered in the case of one abutment, as hereafter explained. The arches and spandrils are of wrought iron. Each span consists of 8 ribs, connected together by 7 sets of transverse radial bracing, the spandrils being also connected together by 6 sets of diagonal bracing. Each rib, at the springing, works on a cast iron knuckle joint. The floor is of buckle plates, riveted upon the ribs and spandrils, and covered with a coating of asphalt ¾ in. thick, over which is spread a layer of concrete. The roadway is macadamized, and the footpaths are laid with granolithic composition. Over the abutments and the piers the parapet consists of massive granite masonry; over the arches it is of open cast iron work. There is provision under the footways for carrying two 27-in. mains, belonging to the Stockton and Middlesborough Water Board.

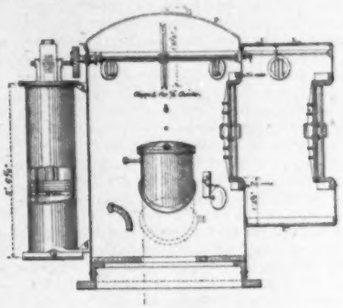
The depth of water at the old bridge was originally very small, and the Tees Commissioners required 12 ft. at low water to be maintained at the new bridge; but this depth came to be considerably reduced, as explained below. In dealing with the foundations, great and unforeseen difficulties were met with, which rendered it necessary to introduce changes into the system of construction. Operations were commenced at the abutment on the south bank of the river, and here the original design was followed, except as regards the levels of the foundations; the bed of concrete on which the masonry rests, and the sheet-piling which incloses it, being both carried down from 6 to 7 ft. deeper; the masonry being also founded at 5 ft. below zero of the tide gage on the old Stockton bridge, instead of at the level of that zero at first designed.

The reason for this change was that the water had latterly been observed to ebb, on several occasions, nearly 4 ft. below the zero, a circumstance attributed to the effect of the works of improvement in the Tees estuary, then in course of execution by the Conservancy Board. It seemed likely, also, that the demolition of the old bridge, and the removal of some of the stone and slag deposited around the piers, would contribute to this action.

The contract did not prescribe any particular mode of sinking the pier cylinders, and the contractors began by adopting open-air dredging with a Priestman grab, the cylinders being loaded with cast iron ingots. The first two cylinders were partially sunk in this manner, but it then became evident that some other process would have to be adopted. The reasons for this were: First, the material underlying the clay bed of the river channel was a fine, silty sand, very liable to displacement; secondly, the foundations of the new bridge coming close to those of the old bridge, which were known to be very shallow, it was apprehended that the dredging inside the cylinders might tend to undermine it; thirdly, the river bed, just below the bridge, had been deepened in places to 22 or 23 ft. below low water, partly from the effect of scour caused by certain protection works at the old bridge, but chiefly in consequence of dredging operations carried on for the convenience of wharfingers.

Soon after the erection of the staging, when work at the south pier was being commenced, it was noticed that, on the ebb tide, there was a considerable scour at the old bridge, and the county authorities became apprehensive for its safety. As a precautionary measure, piles were driven across the river in front of and below the bridge, and wallings were attached to them, behind which slag was deposited, forming a sort of rought weir. This work, while protecting the old bridge, naturally tended to deepen the river bed below.

This deepening of the channel, together with the altered level of low water already mentioned, rendered it advisable to add another 9-ft. length to the cylinders



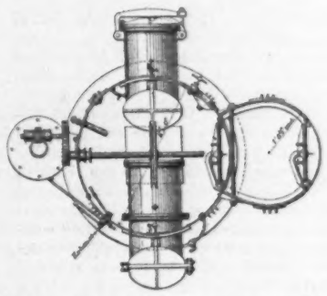


Fig. 3. Pneumatic Air Lock, Victoria Bridge.

of the piers, increasing their total length from 27 ft. 9 ins. to 36 ft. 9 ins., and also made it desirable that the tops of the cylinders should be kept level with the upper surface of the concrete bed at the south abutment, or 5 ft. lower than was originally designed. In view of all these facts, the contractors determined to resort to the use of air locks, and to work under pneumatic pressure for the remainder of the cylinder sinking.

The pneumatic apparatus, of which two sets were provided, is shown in Fig. 3. The main cylinder is 8 ft. in height and 5 ft. diameter; its floor is partially boarded, but otherwise open, the air lock proper being formed by a lateral chamber with two doors, the inner one being fitted on the face of the main cylinder. On the opposite side is a vertical cylinder, 5 ft. 6 ins. in height, and 18 ins. diameter, open at the top, in which a piston is worked by the compressed air. The piston-rod carries a rack which actuates a pinion, giving motion to a sheave which is keyed upon the shaft inside the main cylinder. The excavated material is raised by means of a rope passing over this sheave, which moves 10 ft. for every foot of lift of the rack. The main cylinder is provided with a discharge spout, as well as with a spout for passing in concrete. The latter of these was used, but not the former, as the excavated material was passed out through the air-lock or lateral chamber.

When the pneumatic apparatus was first used, it stood upon a plate bolted to the square top of the pier cylinder, but this casting being, from its form, ill adapted to resist internal pressure, the pneumatic cylinder was, on all subsequent occasions, fixed upon an internal wrought iron tube, which was directly connected with the second length of the pier cylinder, at the joint between it and the top length, the latter being thus relieved of pressure.

The pneumatic apparatus worked well, and by its aid the sinking of the cylinders was carried on steadily and without any casualties. The cylinders were usually concreted up to within 12 ft. of the top before the air-lock was removed, and, under ordinary circumstances, the work done under pneumatic pressure was accomplished in between 10 days and a fortnight for each cylinder. The ground traversed proved to be of a difficult character, consisting for the most part of a fine running sand, and, at about 25 ft. below low water, a bed of coarse sand and small bowlder stones, about 4

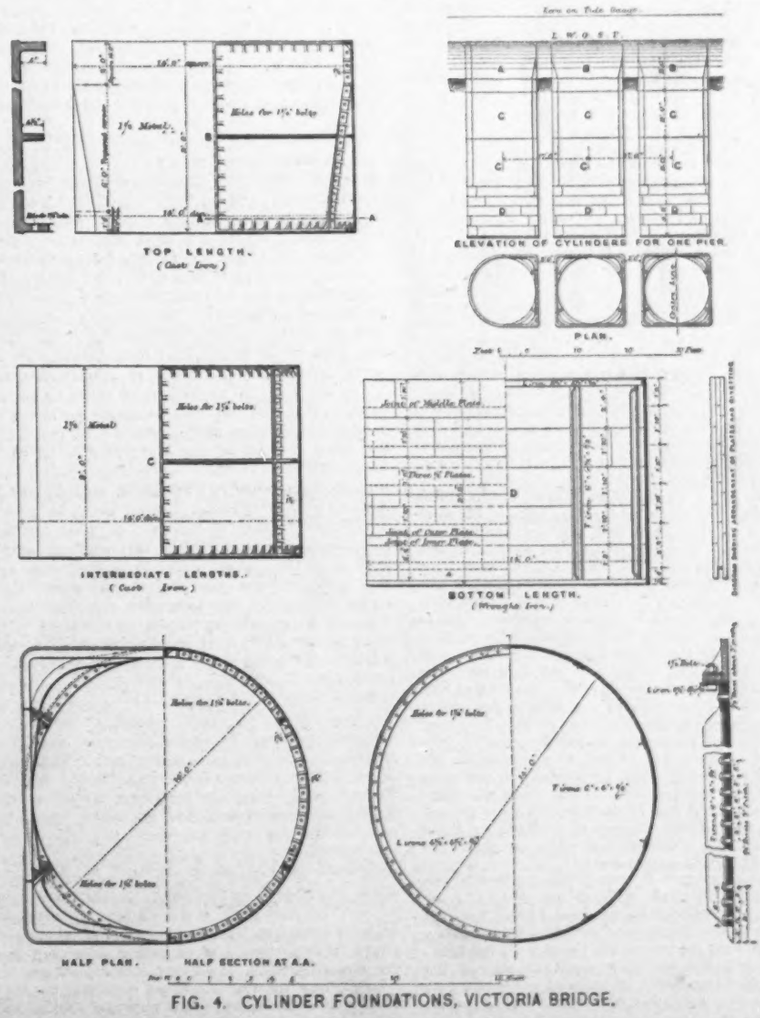


FIG. 4. CYLINDER FOUNDATIONS, VICTORIA BRIDGE.

ft. thick, was met with. One of the cylinders having been arrested in its descent by some of this material, although heavily weighted, the air pressure was taken off for a short time, and the cylinder went down; but it was found that the adjacent cylinder, which was fully concreted up (though it had not then been tested with a load), sank nearly 2 ft. This was the only case of a cylinder subsidence, and it was most probably caused by the motion of the subjacent sand when the air pressure was removed from the next cylinder. The cylinder tops being sunk, as already explained, 5 ft. below ordinary low water, it was necessary to surround them with some kind of inclosure; as there was not only a course of stone to be set in the cylinders, but also the large flat-bedded bridge stone, to connect the several cylinders together. In the case of the first three cylinders this was effected by means of square wrought iron caissons, bolted to the square cylinder tops, open at the top, and reaching to the level of ordinary high water.

The sides of the adjacent caissons, when thus fixed, were almost in contact, and after the course of stone inside the cylinders had been set, the narrow space between the caissons was caiked round, and the intervening plate iron sides were removed, so that the two caissons became one inclosure. The connecting masonry was then set, large blocks being used to bring it up in two courses to the level of zero on the tide gage.

This method of working was successful, but proved to be rather slow, and for the remaining two cylinders of the south pier, as well as all those of the north pier, the contractors preferred to use light cofferdams of pine piling, reaching to about half-tide level, and to set the stones by tide work. Above low-water level the face of the work was built in coursed ashlar, and the backing in rubble or concrete. The cylinder foundations of the north pier were executed in the same manner as those of the south pier, and sunk to the same depth.

While the cylinders for the south pier were being sunk, preparation was made for commencing the north abutment, the foundations of which were originally intended to be carried down in the same manner as had been followed on the south side of the river. The sheet piling to inclose the concrete was accordingly driven, and the excavation was commenced; but, owing to the necessity of carrying the foundations to a greater depth than had first been contemplated, it was now found that they would no longer rest as intended in the bed of clay. In regard to the nature of the ground below the clay, the indications that could be gathered from the excavation, and from the driving of the sheet-piling, were not encouraging; and, before proceeding further, new borings were made, and were carried to a depth of 45 to 63 ft. below low water. These showed that under the clay, or from about the level of 35 ft. below low water, downward, the ground consisted of a mixture of clay and a silty running sand, but chiefly the latter; the clay finally disappearing, and the lowest strata being even more unstable than those above them. Under these circumstances it became necessary to reconsider the mode of construction, and, after reviewing other methods of getting a secure foundation, it was finally decided to adopt a group of cast iron cylinders, covering all the space inclosed by the sheet-piling. This was undoubtedly the most certain mode of dealing with ground of that nature. The cylinders, Fig. 4, were cast from the patterns already at hand, and were disposed in three rows of five each; they were all 30 ft. in length, made up of three cast iron rings of 9 ft. each, and a wrought iron curb of 3 ft., with a cutting edge. The space between cylinders of the same row was 2 ft. 9 ins., and that between row and row was 4 ft. 6 ins. The tops of the first row were sunk level with those of the piers, the tops of the second and third rows being kept each 3 ft. higher than the preceding row. These cylinders were sunk for a considerable part of their depth by open-air excavation; but in every case the pneumatic apparatus was used in order to bring them to the required depth, and they were also partly concreted under pressure. The only casualty of any kind in connection with the sinking was the occurrence of a crack in one cylinder, extending through the whole height of the bottom cast iron ring, and through half the height of the second or middle ring. This fracture was caused by straining of the cylinder in its descent, consequent upon its coming in contact with a bowlder; and, as the crack was sufficient to allow the escape of the compressed air (though otherwise unimportant), it was made tight by lining the segments with a wrought iron plate, and filling the space behind it with cement grout.

The ground traversed in sinking these cylinders was very similar to that met with at the piers, and the same layer of bowlders also occurred, as had been apprehended. It was not thought necessary to use cofferdams of any kind for setting the masonry on the cylinders. The cylinders of the second, and also of the third row, were connected by pairs of small cast iron girders, between which flat brick arches were turned; while in the first row they were connected by large flat-bedded stones, set at low water of spring tides, and the space between row and row was similarly bridged over by large stones. Above this platform the masonry of the abutment was carried out in accordance with the original design. The depth to which the cylinders of the abutment and piers were carried rendered it most unlikely that they should ever be affected by any deepening of the river bed; but the subsidence of a cylinder during the construction of the south pier, already described, showed how necessary it was to avoid the risk of any disturbance from this cause. Every cylinder, after being filled up with concrete, was subjected to a test load of 300 tons, kept on for 10 days, and all successfully sustained the load.

Notwithstanding the treacherous nature of the soil, the bridge has stood securely since its erection, and there has been no appearance of settlement, either at the piers or the abutments. It was opened for public traffic on April 4, 1887, but its formal inauguration took place on the 20th of June, 1887—Jubilee Day—when it was named the Victoria Bridge. The total cost of the work, including the approaches and paving, as well as land and compensation, was $345,255.

WEAR OF STREET RAILWAY TRACK WITH STEAM MOTORS.

At the meeting of the Tramways' Institute of Great Britain and Ireland, in London, June, 1892, Mr. T. Arnall, Assistant Surveyor of Birmingham, read a paper on "Permanent Way Construction, Especially in Regard to Wear and Tear and Depreciation," having especial regard to experience in Birmingham. When street railways were first built in Birmingham, in 1872 and 1875, they were built and maintained by the city and operated by private companies upon terms arranged with the operating companies. About 4½ miles of track were laid with the Larsen system, consisting of a saddle rail with flat groved head and two vertical legs embracing the top of a wooden longitudinal, but the timber warped and shrunk and the rails became loose. Mr. Arnall's paper referred especially to the wear of girder rail track under the steam motors which were introduced later, and we give the following abstract of this paper, which is of particular interest at this time when so much attention is beginning to be paid to the improvement of street pavements and street railway tracks.

The Birmingham steam motor cars, or dummy engines weigh about nine to ten tons and haul a large car carrying 60 passengers. They have cylinders 8 × 14 ins., and driving wheels 2 ft. 6 ins. diameter. The life of the driving wheel tires is 23,000 to 25,000 miles, which is a short life, but the grades are heavy, 4% to 5%, and sand is frequently applied. They were built by Kitson & Co., of Leeds, and the Falcs Engine Co., of Loughborough, and cost about $3,750. According to Wellington's "Economic Theory of the Location of Railways," the life of first-class 60 to 80 lb. steel rails on ordinary railways is about 150,000,000 to 200,000,000 tons. There are from 10 to 15 lbs. of metal or ⅝-in. to ⅝-in. in depth of the head available for wear, and abrasion takes place at the rate of 1 lb. per 10,000,000 tons, or 1-16 in. per 14,000,000 to 15,000,000 tons. The rate of wear is increased about 75% by sanding. The wear of street rails, according to Mr. Arnall, is 750,000 steam motors, weighing 10 tons, or 7,500,000 tons. If we suppose the rails to be continually sanded by street dirt and grit and by sand from the engines, and add 75% of wear from this cause, and also add 25% for the wear due to street traffic and the passenger cars, we have a wear of 15,000,000 tons only, or one-tenth of the wear of the rails of an ordinary railway. Reasoning upon this basis, it appears that the most economical results in maintenance and renewals of street railway track may be obtained by a track in which the upper part, or wearing head, of the rails is removable without disturbing the entire track, as is necessarily the case with girder rails. In a paper by Mr. T. Graham Gribble on "Street Railway Track," read before the American Society of Civil Engineers (Eng. News, Dec. 20, 1890), the author came to the following conclusions: 1, the wear of the rail head is much greater on street railways than on steam railways, and that the head of a street rail should be removable; 2, the attachments of the movable rail head should be accessible without disturbing the pavement; and, 3, rails for street railways should be of harder steel than those for steam railways.

Steam traction was introduced into Birmingham in 1882, and has since received a very extensive development; its growth was rapid, but soon checked. Between 1882 and 1887 the three companies using steam on the Birmingham tramways acquired altogether about 120 locomotives. The paper deals more particularly with the effect of this steam traffic upon the track, and the Birmingham results are the more important because the traffic upon the lines is so exceptionally heavy. In some streets there are four lines of routes overlapping each other, and in other streets as many as five lines, each route having quite a full complement of cars running over it. The result is that we have as much wear and tear on these tramways in four or five years, as we get on a single route in 20 years. This is, of course, apart from the effects of ordinary traffic, which I believe to be very small indeed.

Knowing, then, the actual amount of wear in five years where four routes run over the lines, we have a good guide as to the amount of wear which a line over which the traffic from only one route passes will sustain in 20 years. Many things may conspire to increase the effect on the single route in the long period of 20 years, such as corrosion, the long continued effect of ordinary traffic, the natural growth of the district and consequently more frequent service, and so on; but I know of nothing that can possibly diminish the effect, except that the engines, etc., taken over the lines be reduced in weight or number, which can hardly be expected.

Generally speaking, every case of repairs is a renewal of some part or another; it may be the replacing of a broken switch, or only the renewal of the bedding under the adjacent paving stones, or of the grouting between them. Those engaged in the maintenance of steam tramways generally have a pretty good notion as to what every day repairs means, but the almost imperceptible wear and tear to the rails themselves, which is always going on, but which generally takes a long time to make itself visible, when not overlooked altogether, is generally only provided for in an indefinite sort of a way by a depreciation fund. The traffic on some of the steam routes in Birmingham has already produced some results which may serve as data to assist in determining what this depreciation fund should be in similar circumstances, and, properly interpreted, may even be of service in circumstances which are not similar.

The first tramway laid for steam in Birmingham was the Birmingham and Ashton route, in 1882, a length of about one mile of double track inside the borough, laid by the Corporation, and a further length of about 3 miles in the district of the Ashton Local Board, laid by the Ashton Tramway Co. The gage was 3 ft. 6 ins., laid with the Barker track, consisting of a 42-lb. steel rail of flangeless T section, keyed to a cast iron chair or longitudinal (Fig. 1). The chairs were cast in lengths of 2 ft. 11 ins. and laid with a gap of only 1 in. between them, so that they were practically continuous. They were molded by machinery, and were as near true on the upper surfaces as castings not machined can be, and though they formed a nearly continuous line, it soon became evident that they did not form a continuous bearing for the rail. In a very short time after the line was opened the rails began to work loose at the joints, which were always in center of sleepers, and in spite of all tightening up and replacement of keys, this defect gradually spread along until the rail was loose from one end to the other; and the next result was, of course, the loosening and sinking of the paving stones alongside. A length of 600 to 900 ft. in Corporation St. was left unpaved, and here the keys could be readily got at for tightening up, etc., but it was found that the rail did not become loose because the keys were not tightly driven in, but because they were cut away by the harder rail. A trial of some steel keys was made, but it was found that they caused the edge of the hole in the rail itself to cut away, so they had to be abandoned.

It was found that the steam traffic was really subjecting the rail to a process of "cold rolling," which lengthened out the upper surface, while the lower parts of the rail remained unaltered. As a result, the rail tended to assume an arch or bow form, and when all the keys in a 30-ft. length of rail had been knocked out, the loose rail rose in the center 6 or 9 ins. Furthermore, it was no longer straight on plan, but curved, the tread or bearing surface of the rail being on the outside of the curve. The effect was that when keyed down the rail was always in a state of strain, and the least looseness in the keys caused it to rise above its bed, and at the same time the horizontal curvature caused it to move sideways, so that when a car passed over it the lower parts of the rail did not fall directly in their proper places on top of the sleeper, and dust and grit from the road surface formed a most efficient grinding material, which was constantly being renewed. Thus, the top of the chair wore away as fast, practically, as the top of the rail, and, moreover, it wore out of shape, and the notion that we should be able to replace the rails when worn out without having to disturb the chairs, had to be definitely abandoned. This process went on until the flange of the wheel reached and ran on the bottom of the groove, and then destruction went on more rapidly still, until, toward the end of 1886, when the lines had

been in use four years, some of the rails began to split along the groove and had to be taken out, thus terminating their career.

Four years seems a short life for a tram rail, but the conditions must be taken into consideration. The rail was in a macadam road, and the traffic over it, amounting to, perhaps 30,000 steam cars in 1883, had rapidly increased until the fourth year when it had to carry the traffic from five different routes, amounting to 120,000 cars in that year. The total in four years amounted to about 280,000 cars, roughly equivalent to somewhere about an average of five minute service during the period.

In lower parts of the tramway, where the road was

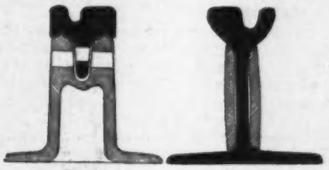


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9,

Fig. 10.

WEAR OF STREET RAILWAY RAILS.

paved all across, and where some of the traffic had been diverted down other streets, the wear and tear was not so great. Nevertheless it was found necessary to take out and replace all the rails before the end of 1889, after the passage over them of about 380,000 steam cars in seven years. Outside the borough boundary the tramway company contrived to carry on for a few months longer, but took out their rails in the following year, after having been in service about 7½ years and carrying the traffic of rather more than 400,000 cars.

Our experience thus shows that, apart from all questions of ordinary everyday repairs to paving, switches, etc., the Barker rail will be worn out and done with, and must be replaced, after the passage over it of about 400,000 steam cars. If the new rails have to be put in at night and without disturbing the traffic, it may be taken that a mile of single track will cost about $10,000 in relaying it with girder rails, which is equivalent to about 2½ cts. per car mile as a sinking fund to provide for the replacing of the rails alone.

The result of this experience was that when, in 1883, the city was called upon to construct the lines of what is now the Birmingham Central Tramway, the conclusion had been arrived at that the Barker system was not suitable for steam traction. The system decided upon for the new tramways was the Gowan, or girder, rail, 7 ins. deep, to suit 6-in. paving, 7 ins. wide over the base, and weighing 98 lbs. per yd. (Fig. 2). The joints were made of two 16-in. fishplates, with four bolts, and were generally found to stand very well on a single route for the first two or three years, equivalent to the passage of, perhaps, 60,000 to 70,000 cars over them. After this they began to work loose, and the remedies resorted to—viz., tightening up the bolts and often replacing them, repacking the rail, etc.—are found to be only a temporary cure. For some time it was thought that the working loose was due to the nuts slacking back, or to the bolts stretching, and various varieties of locking nuts were tried, but with no beneficial results. The bolts may certainly have stretched a little, but the nuts certainly did not slack back or work loose, and it appears that the failure at the joints was due to several causes, which may produce different results under different circumstances.

It is not easy to imagine how a line of rails, properly spliced together, and supported continuously on a solid bed of concrete, can work loose at the joints, but it is very certain that they do. The chief reason is to be found in what I believe to be the fact, that on a steam route the rail generally is not continuously and equally supported, and, furthermore, it never can be for long together. The rail bears more solidly in some places than it does in others, bridging over the hollow places, and there is, consequently, a minute deflection as the load passes over the places that are least firmly supported. When the joint happens to be over one of these slack places in the concrete the deflection will be greater. In the section of rail under discussion, deflection can readily take place, the head of the rail sinking between the tops of the fishplates, wedging them open. To be effective in resisting a tendency of this sort, each fishplate should act like an arch, the bolts passing through the crown, the abutments being at top and bottom of the plate. In the Birmingham section, however, though we have a fairly good abutment at the bottom, there is a very bad one at the top, and sliding can, and does, very readily take place there. The narrow edge of the plate is not a good surface for withstanding an action of this sort; it is too narrow; this is very plainly seen when a loose plate is taken off, the top and bottom edges being often ground quite bright and smooth, and generally, a more or less deep ledge is worn in them by the extreme ends of the rails.

Many attempts have been made to deal with this weakness at the joints, with but imperfect success. In the last route constructed by the Corporation the length of fishplates has been increased from 16 to 24 ins., and the number of bolts from four to six, but the traffic on this line is comparatively slight, and as yet the soundness of the joints upon it is no criterion of what we might expect on a steam route with heavy traffic. A large number of Marshall's soleplates have been used; at first the plates were 16 ins. long, with four clips on each side, but these not being in all respects satisfactory, the length was increased to 22 ins. These long plates were practically no better than the short ones, if so good. More close attention being paid to the movements of a loose joint under the traffic, it was seen that the defect was rather with the clips, so I suggested that the two center clips should be brought close together, and coalesced into one, the two bolts being retained. This form of clip turned out to be a great improvement on the old form, and I believe the plate is now as good as a soleplate can be expected to be. It should be remarked that in our work these plates have been under one disadvantage, inasmuch as with the exception of one route, and that of light traffic, they have been put under joints that were already faulty, and mending a bad joint is not such easy work as delaying the failure of a good one.

To find what the effect of increasing the bearing area at top and bottom of the fishplates would be, a number of cast iron plates 16 ins. long, and of the section shown in Fig. 3, were prepared. They fit the rail closely at top and bottom, and the top is brought up to the street surface, and finished with a corrugated surface, and it will be seen that in screwing up the bolts there can be no tendency to make them ride up on their abutting surfaces. A trial length of line was selected, and a number of these plates put in in the autumn of 1890 in a street of very heavy traffic, and their behavior is being compared with joints of other forms made at the same time in the same street, and under precisely the same conditions. They are still standing very well. Where these plates are used without soleplates the joint seems about equally good as when fishplates and soleplates are used, and where it has been combined with a soleplate the joint is better than any that has yet been tried in Birmingham. As the plates have been in 20 months only, it seems too soon to speak very positively of their merits; nevertheless, it is worth remarking that in that time they have had more than 250,000 steam cars over them, or the equivalent of a ten minutes' service for about twelve years.

To refer again to the "cold rolling" process which has been already mentioned, I am persuaded that this action is one reason why we have so much trouble with the joints; its whole tendency is to lift the rail off its bed, allow dirt, etc., to get underneath in irregular patches and thereby destroy the continuity of the bearing. The dipping at the joints, which is such a marked feature in a well worn steam tramway, is not so much a lowering at the joints as a lifting of the intermediate parts of the rail, and it is found that whenever a rail gets this hog-backed appearance, the trouble with the paving, which at first was only experienced at the joints, is now found pretty general all along the rail. It is furthermore to be remarked that the curving up in the center is very much more with the same amount of traffic on a 6-in. rail than it is on a 7-in. rail, and so much is this so that I venture to advance the opinion that nothing less than a 7-in. rail is fit for use on a steam tramway of a moderately heavy traffic.

Figs. 4 to 10 show actual sections of some rails that have been taken out of the Birmingham tramways, showing the effects of wear upon them.

Fig. 4,	tangent,	effect of	.....	555,000 cars
" 5,	flat curve,	"	.....	570,000 "
" 7,	sharp curve	"	.....	570,000 "
" 9,	tangent,	"	.....	560,000 "
" 6,	"	"	.....	670,000 "
" 8,	"	"	.....	670,000 "
" 10,	"	"	.....	670,000 "

All these sections show more or less the effect of tilting over of the rail, which is always to be found on a steam tramway, has upon the wear and tear of the rail. The tread is not evenly worn down, but more rapidly toward the groove, leaving the flange up as a more dangerous obstacle to the ordinary traffic. From them some idea may be obtained of the great advantages which a rail with a central groove would have over one of ordinary section. These sections show that on a straight road a girder rail will be worn out and require replacing after the passage over it of less than 750,000 steam cars. Many things may cause the number to be less, but nothing, except reduction in weight of the engines can cause the number to be greater. Taking the cost of relaying at $10,000 per mile, it follows that over and above the cost of every day repairs, and maintenance of paving, etc., a damage to the extent of certainly over one cent per mile is accumulating on the rails, and may some day want paying off all at once. This liability seems to form a very definite factor in any depreciation fund that may be set aside for future requirements.

WATER-TOWERS IN MASSACHUSETTS.

In another column, Mr. Sylvester Baxter, describing the pleasure-grounds of Wakefield, Mass., alludes to the great architectural beauty of the distant water-tower at Reading, a view of which can be had from the pleasure-grounds at Wakefield.

These water-towers are becoming marked features of the Massachusetts landscape. Every town of any considerable population has its water-works, and as the sources whence water may be drawn by gravity are exhausted, water-towers, or "stand-pipes," have become a necessity. They mark the hill-tops of eastern Massachusetts in every direction, and form notable landmarks, but with very few exceptions, they are not as beautiful as they are conspicuous. They are usually plain cylinders of iron thrust up into the air like enormous steam-boilers, much elongated and set on end, or like very thick, unsharpened lead-pencils, and they disfigure the landscape as a heavy, black perpendicular mark would deface a fine painting. Perhaps there is none more conspicuously ugly than that of Swampscott, the obtrusive presence of which must be very irritating to the summer residents along that beautiful and fashionable shore. Various other suburban communities offend in a hardly less degree. Malden, for instance, has a particularly bad one, unique in these parts, serving both as a tank and stand-pipe, and looking like a gas-holder, perched upon the summit of Wait's Mount, a fine rocky hill rising boldly out of the heart of the city. The offense is the more aggravating because several acres of the top of this hill have been reserved as a pleasure-ground. It is much to the credit of Boston that care has been taken to give architectural character to the several water-towers erected upon prominent elevations in various quarters of the city, the slender, white, minaret-like structure in Roxbury taking precedence in grace and beauty.

All persons of good taste and public spirit should unite in urging upon the local authorities the importance of true proportion, at least, in these structures, something which might be obtained at little or no additional expense. We condemn the Romans for their prosaic utilitarianism, as reflected in their public works. But their aqueducts and bridges had, at least, the merit of a simple grandeur, dignity and true proportion, while, in this age of iron, our useful constructions are apt to be obtrusively ugly.

It would be a wise reform to combine the monumental with the useful in our public works. It is now the exception when either our monuments or our structures of utility are constructed in accordance with sound architectural principles. There are very few out of the thousands of "Soldiers" or "Soldiers and Sailors" monuments that have been erected since the civil war, which, in after years, a cultivated taste will not condemn. The useful and the monumental have, in many instances, been united with gratifying results in

memorial halls, libraries, etc., and this custom is happily growing. One of the best forms of a memorial is a public pleasure-ground, and this idea is also obtaining popularity in many directions. There are also a few instances of memorial bridges—a most admirable form of monument.

If, however, either a community, or a beneficent individual, desires to erect an architectural monument, what better basis for such a structure could be found than that of a water-tower? Towers, pure and simple, have little use nowadays, and their erection in connection with public buildings is usually a waste of money which might otherwise be applied to much better advantage. But a water-tower is, in many communities, an indispensable object. It could be either united with a public building, or it might stand apart in the midst of a public square, like an Italian campanile, or, erected upon a neighboring hill-top—in a park for instance—it would serve as a fine lookout point as well. In erecting monuments, merely as such, the lack of means adequate to the purpose is apt to give them a bare or scrimpy look. A water-tower must, of necessity, have ample proportions, and this fact would assure dignity and impressiveness if it were made the motive for a monument. Those communities which have monuments to erect would therefore do well to expend the money at their disposal for the purpose either to build a monumental water-tower, or, if they already have the misfortune to possess one of the ugly bare cylindrical monstrosities, to turn the fact to account by inclosing it with a suitably designed exterior of masonry—either of stone or brick, according to their means—embellished with suitable decorative work in the way of carving, sculpture, and inscriptions. A monument of extraordinary beauty, either simple or elaborate in its decorative features, might thus be obtained, and its place in the esteem of the public, together with the honor accorded to the individual thus commemorated, would be heightened by the fact that the structure was of constant service in distributing throughout the community one of the most indispensable of life-giving elements—the blessing of pure and abundant water.—"Garden and Forest."

LONDON SEWAGE DISPOSAL.

Among the papers read at the late meeting of the British Association was one by Mr. Crawford Barlow, on that ever-important question, the disposal of the sewage of London. The author first points out the lack of capacity in the present drainage system to handle both sewage and rainfall; and he proposes to utilize some of the old sewers for carrying rain water direct to the river. But to do this with existing sewers, originally built to relieve the main drain in time of heavy rain, parallel intercepting sewers would have to be built one on each side of them. Smaller rain water conduits would also have to be constructed leading into the larger rain water drains.

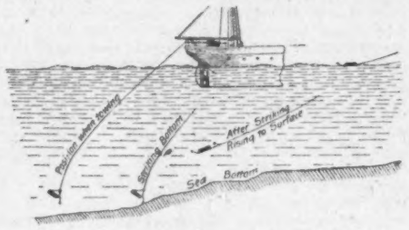
The disposal of the sewage is a separate and larger problem. The dry weather sewage flow is now 180,000,000 gallons daily, and the proposed new intercepting sewers would add to this and amount to a discharge of 300,000,000 daily at Barking and Crossness. The sludge is now 40,000 tons per week, and with the new sewers and the best precipitation results would amount to 70,000 tons. The solid matter is one-tenth of the whole volume, and the deposit of this matter at the present point of discharge must work most disastrous effects on the navigable channels at the mouth of the Thames.

Mr. Barlow points out that Parliament, in 1858, sanctioned Sir Joseph Bazalgette's scheme for discharge at Barking and Crossness, only as a temporary arrangement; and the Royal Commission, in 1884, strongly recommended that there be no discharge of sewage into the river above Hole Haven and no disposal of sludge except in the open sea.

These restrictions would impose enormous expenditure of capital, and the author believes land treatment would be more economical. He estimates 10,000 acres as the land required, not necessarily in one tract. He pointed out on a map of Essex what he considered available land, high and with a gravel subsoil. He proposed to elevate all sewage 50 to 60 ft. above tide, at Abbey Mills, and then to build a conduit following the contour to Hole Haven or Crouch River. Mr. Barlow showed figures to prove that the annual cost of disposing of London sewage is now only 36 cts. per head of population, and there are 1,500,000 persons for whom no capital outlay has been made. The author proposes the erection of a separate London sewage trust, and a special tax upon all persons who foul the river. He assumes that in 30 years the population of the metropolis would be 7,000,000 and the sewage to be disposed of would be from 500,000,000 to 600,000,000 gallons per day.

SUBMARINE SENTRY AND SOUNDING MACHINE.

The purpose of the device here illustrated is to supply an immediate and automatic warning of the approach of a ship to shallow water, and thus to prevent the danger of stranding. The sinker is an inverted kite, termed the "sentry," and can be towed steadily at any required depth down to 45 fathoms. Should it strike bottom through the water shallowing to less than the depth the sentry is towing at, it will at once free itself and rise to the surface, simultaneously sounding an alarm on board. The vertical depth at which the sentry sets itself, when a given length of line is paid out, is not changed by any variation of speed between 5 and 13 knots, and is indicated on a graduated dial plate on the winch by which the line is paid out or hauled in. The



The James Sounding Device.

graduations of the dial plate for vertical depths have been carefully calculated, and their accuracy verified by numerous comparisons with Admiralty soundings under all conditions of speed and weather.

Accurate single soundings to 45 fathoms depth can be taken at any time while the ship is under way, the sentry being let down slowly. The gong will indicate when bottom is touched, and the dial will show at once the vertical sounding close to the ship, without waiting to haul in the line. The dial is also graduated to show the actual length of line paid out, so that, when required, soundings to 200 fathoms can be obtained by stopping the ship and using the ship's lead instead of the sentry. The device is the invention of Mr. S. H. James, and is manufactured by the James Syndicate, 18 Billiter St., London, England. It is in use in the British navy and on ships of the Allan Line, Clyde Shipping Co., Royal Mail Steamship Co., and other shipping companies.

PERSONALS.

Mr. H. A. Fisher, General Manager of the St. Louis, Chicago & St. Paul R. R., has resigned his position.

Mr. Geo. F. Wright, an engineer of the Arrowhead Reservoir Co., died at San Bernardino, Cal., Aug. 20.

Mr. J. A. Farleigh has been appointed Chief Engineer of the Harriman Coal & Iron R. R., vice Geo. F. Simpson.

Col. G. L. Kimball, of Dardanelle, Ark., President of the Dardanelle & Russellville Ry., died at Concord, N. H., Aug. 29.

Mr. Alexander Kirkland, architect, died at Jefferson, Wis., Aug. 29. He was for eight years Commissioner of Buildings at Chicago.

Mr. Henry H. Holly, one of the first members of the American Institute of Architects and author of works on church and residence architecture, died in New York City on Sept. 5.

Mr. Wm. J. Gillingham, Jr., has been appointed Signal Engineer of the Illinois Central R. R., with headquarters at Chicago, and reporting to Mr. J. F. Wallace, the Chief Engineer.

Mr. Rudolph Hering has been engaged to report upon the water supply question of Tacoma, Wash., and is now on his way to the Pacific Coast, stopping en route at Sioux Falls, S. D., to report on its sewerage.

Mr. Luther D. Eddy, for many years engaged in engineering work at Troy, N. Y., died in that city on Sept. 3, aged 82 years. He was at one time a partner of Prof. David M. Greene, of the Rensselaer Polytechnic Institute.

Mr. Wm. W. Marsh, of Schooley's Mountain, N. J., died Aug. 29. He was President of the Union Canal Co., a director of the Thomas Iron Co., and was connected with the Taylor Iron Works, of High Bridge, N. J., and other iron and manufacturing companies in New Jersey. He was 65 years of age.

Mr. Benezette Williams is Chief Engineer of the Chicago drainage canal, now commenced. His principal assistant engineer is Mr. Thomas T. Johnston, with Assistant Engineer Mr. B. C. Dunlap. Mr. L. E. Cooley, to whose persistent effort much of the credit for the present status of the work is due, is one of the Trustees of the Board and Chairman of the Engineering Com-

Mr. R. H. Hood has been appointed to the chair of civil engineering in the University of Missouri. Mr. Hood graduated from the Rensselaer Polytechnic Institute in 1887, and was successively engaged in bridge work in Louisville, Ky., in a personal investigation and study of the Panama Canal for New York interests and in railway location and work in West Virginia. He was later Superintendent of the Davis Coal and Coke Co., of W. Va., and in 1890 was Chief Engineer of the Seaboard Air Line Railway.

Mr. E. Sherman Gould, consulting engineer to Messrs. Runkle, Smith & Co., of New York, has returned from Havana for a vacation. He reports the work upon the Havana water supply, of which he is engineer for the above named contracting firm, as approaching completion. This work was commenced in 1890, and at the present time about 80 miles of pipe, weighing about 7,000 tons, have been laid, and the Palatino reservoir is nearly ready to receive water. The date of completions can not be definitely fixed, as the city authorities have not yet decided the amount of work to be done under the contract.

Mr. Eben Cedron Smeed, Chief Engineer of the Union Pacific system, died at Philadelphia, Pa., on Aug. 24. Mr. Smeed was born at Windsor, Vt., Dec. 8, 1831, and at an early age went with his father to Pennsylvania, where the latter had lumber interests, and was later an engineer and railway superintendent. Eben C. Smeed commenced his professional life as a rodman in 1851. He advanced rapidly, and among the earlier important works with which he was connected were the old Portage bridge, on the Erie Railway, and several large stone arches still standing on the Delaware, Lackawanna & Western Railway, near Scranton, Pa.

At the outbreak of the Civil War, Mr. Smeed entered the army of the North and was assigned to duty under Gen. Herman Haupt, then in charge of the Dept. of Military Transportation for the Army of the Potomac. His good work won him a place on General McDowell's staff with the rank of Colonel. He is credited with having supplied a shortage of 2,000 ft. of telegraph wire on one occasion, by ordering out two regiments of soldiers, who standing 2 ft. apart formed a line across a ravine and with their iron ramrods supported horizontally on forked sticks furnished a metallic connection "through which the telegrams were sent." Colonel Smeed also superintended the laying of the first pontoon bridge across the Rappahannock on the occasion of General Burnside's ill-fated attack on Fredericksburg. After the battle of Gettysburg, Colonel Smeed was transferred to General Thomas' command, and, in opening the railway to Chattanooga, accomplished the feat of rebuilding in four days, with material from the woods, the long and high trestle bridge on the Nashville, Chattanooga & St. Louis Ry., 15 miles north of Chattanooga. He returned to the Eastern army when General Sherman commenced his march to the sea, and was present at the reduction of Fort Fisher, and then proceeded to open railway communication southward to meet General Sherman. Colonel Smeed was wounded several times and at the close of hostilities declined an honorable position in the Corps of Engineers, U. S. A. After the war, Colonel Smeed entered the service of the Kansas Pacific Ry. in 1866, and as Resident and Chief Engineer remained with that company until it was consolidated with the Union Pacific system. He was made Asst. Chief Engineer of the newly formed organization and in Feb., 1891, he became Chief Engineer. He was buried on Aug. 28 at Emporia, Kan.

NEW PUBLICATIONS.

SEPTEMBER MAGAZINES.—Mica and the Mica Mines are described by C. Hanford Henderson in the "Popular Science Monthly." North Carolina has produced most of the mica mined in this country, but at present East Indian mica is said to be driving out the American article. The increasing use of mica in electrical work ought to cause the reopening of some of the idle American mines. The marine biological laboratory at Woods Holl, Mass., is described by J. S. Kingsley. It is a private school for work in marine biology, not a government establishment, as many suppose from the fact that the United States Fish Commission has its laboratory and hatching station at the same place. A paper on "Infectious Diseases," which seems especially opportune at the present time, gives the latest results of bacteriological study, which are to the effect that recovery from disease caused by bacteria and the effect of vaccination or inoculation in conferring immunity from the disease, is due to the presence in the blood of an "anti-toxine," a product of the bacteria themselves, which either kills the intruders or neutralizes

their action. Edward Atkinson's paper on "Personal Liberty" in the February number is answered in this by Conrad Reno, who argues that the personal liberty of the workingman is not injuriously affected by legislation fixing the hours of labor or making arbitration compulsory. He says very truly that in times when England passed laws giving employers power to fix wages and punishing laborers who asked or employers who gave more than the legal wages, no one was found to object that personal liberty was being interfered with. Both the "North American Review" and the "Forum" devote considerable space to the Homestead strike. In the former, Hon. Wm. C. Oates, Chairman of the Congressional Investigating Committee, makes some political capital from it, Geo. Ticknor Curtis discusses it from the standpoint of the old-school economist, and T. V. Powderly tells how a Knight of Labor looks at it.

Among the shorter papers in the "North American Review" is one on "Cholera," by Dr. Cyrus Edson, of the New York City Health Board. He emphasizes the great influence of polluted drinking water in spreading the disease, and says that generally speaking the water supply of American cities is exceedingly pure. It is difficult to contradict general statements, but we fear the above is rather too favorable an opinion of the purity of city water supplies, taking the country as a whole.

The "Forum" contains three papers of rather unusual interest. Prof. Thurston's paper on "The Next Great Problems of Science" (the inter-conversion of heat, electricity and light, and work with vastly more efficiency than we now do, to correspond with the analogies) is very unusually interesting and suggestive, and deals with a problem of the deepest interest, with possibilities in it which may vastly hasten the progress of civilization. We notice only one thing which we could wish otherwise, a slight misuse of the word "thermo-dynamic" in taking for granted that the direct conversion of heat (or its equivalent) into work in the human body "is not thermo-dynamic" because only so (i. e., by not being thermo-dynamic) could the law of Carnot be evaded. It is perfectly true that all the heat engines which are as yet practically known to us are of the crude type so brilliantly investigated by Carnot, but to assume that that type exhausts the possibilities of heat-engines, and therefore that thermo-dynamics can relate only to that type, is to assume too much. We may any day be astounded by the production of a possibly much simpler type of heat engine which will use fuel vastly more economically, and as economically as it is used in the human body. The steam engines on which we pride ourselves, are, after all, nothing more than man's first attempt at converting the occult sources of energy into work. It is natural that they should be relatively clumsy and wasteful, and probable that they will all go in time to the scrap heap or museum of antiquities.

Hon. Chauncey F. Black has an article on "The Lesson of Homestead" which would have been more effective if it had not been so heated and one-sided in tone, but which tells many truths which deserve to be carefully weighed, and one novel and weighty suggestion on which we have commented elsewhere, which might possibly do much to soften the antagonism between labor and capital; that working men be authorized by law to form corporations for dealing in labor analagous to those of capitalists for managing capital, under suitable conditions giving such corporations financial responsibility, so that they can sue or be sued, and enforce or be held to contracts. Two "Studies in Immigration," by Prof. K. C. Babcock and Henry Rood, both strongly favor restrictions upon further indiscriminate immigration.

In the "Century," we find an interesting description of a journey to the falls of the Grand River in the interior of Labrador, a cataract with a total fall of 316 ft. The normal width of the river is about 1,000 ft., but it is contracted at the fall to a width of about 150 ft. The chasm below the falls is similar to that which has been excavated at Niagara and is about 25 miles in length in a hard gneissic rock, indicating an enormous length of time for its formation. Another paper describes the first experiment in exploring Alaska with packhorses, all previous expeditions having employed Indians to carry their supplies. Mary Hallock Foote's irrigation novel is to be finished next month. In this month's installment we are told how the General Manager of the Irrigation Co. orders the Chief Engineer to found a dam on piles, a plan which the latter has protested against. The engineer writes a letter of resignation, but thinks over the matter over night and tears it up. The description of his mental conflict is an excellent one. We quote the following bit:

> The truth concerning his resignation would never be known. Gossip would have it, in circles where an engineer's reputation is discussed, that here was a presumptious dreamer who fancied himself called to a great work and was found unequal to the initial problem of its fulfillment. How he hated that word the-crist! There was nothing he so loved as to be considered practical. . . . . .
>
> Yet why assume that it was a betrayal of the work. It was well enough known that there is an heroic margin outside the beaten track of precedent, which bold spirits yet may tread.

In the Open Letters, Gen. Herman Haupt gives a most interesting bit of history touching the escape of Lee's army after the battle of Gettysburg. In "Harper's," Julian Ralph continues his series of papers on the new Northwest, describing Washington, "the Evergreen State." He thinks that Washington will support a larger population than Montana, although its mineral wealth is not as great. In "Scribner's," Mr. John Bigelow, one of the executors of the late Samuel J. Tilden's estate, outlines a plan for the erection of a great library on Bryant Park in New York City. We are pleased to notice that Mr. Bigelow has a strong appreciation of the need of a great scientific library in New York City, and he names a contingency in which Mr. Tilden's bequest may be devoted to the establishment of such a library. In any event, the Tilden library may be expected to be especially complete and valuable in its collection of scientific works. In the "Historic Moment" series, Lieut. D. L. Brainard, of the Greely Arctic expedition, tells how, in company with Lieut. Lockwood, he reached on May 15, 1882, latitude 83° 24', the most northern point thus far reached by civilized man, unless Lieut. Peary's party has attained a higher point this summer. In the "Californian Illustrated Magazine" is a paper on "How to Secure Good Municipal Government." The writer thinks that if the intelligent and those who really desire good government would all vote, the bosses would be dethroned. How to induce this class of voters to do their duty and what to do in the many cities where this class is outnumbered by the "controlled" vote, are problems which the writer does not attempt to solve. Another interesting article in this number, describing yachting in San Francisco, is from the pen of Mr. Chas. G. Yale, Editor of the 'Mining and Scientific Press."

MINERAL RESOURCES OF THE UNITED STATES, 1889 and 1890. David T. Day, Chief of Division of Mining Statistics and Technology, Department of the Interior; U. S. Geological Survey, J. W. Powell, Director, 1892. Government Printing Office, Washington, D. C. 8vo, pp. 671. 50 cts.

While this report is somewhat late in appearing, like its predecessors, it is a valuable review of the mineral resources of the United States. So much of its contents, however, have already been made public in the various Census Bulletins that it is not necessary to enter into much detail here. The various statistical tables have been carried forward to date, but the previous six reports should be consulted for general information concerning the mineral industries prior to 1889.

THE LAW OF INCORPORATED COMPANIES OPERATING UNDER MUNICIPAL FRANCHISES; Such as Illuminating Gas Companies, Fuel Gas Companies, Electric Central Station Companies, Telephone Companies, Street Railway Companies, Water Companies, etc. Preceded by an Exhaustive Discussion of the Economic Principles Involved in the Operation, Control and Service of Such Companies.—By Allan R. Foote; Chas. B. Everett, A. M. LL. B., Editing Attorney, with a Resident Attorney in Each State. Cincinnati: Robert Clark & Co. Advance Sheets.

Mr. Foote has undertaken a work of great magnitude which, if thoroughly and impartially carried out, will be a valuable addition to our knowledge of the legal relations between companies enjoying municipal franchises, on the one hand, and the state and municipalities on the other. While we rarely notice at length works which are merely announced, some more detailed notice of the scope proposed for this work may be of interest.

Mr. Foote states that the book will give "the law as it is found written in the constitutions, the enactments of legislatures and the court decisions of the several states and territories, and the decisions of the circuit courts and the Supreme Court of the United States." To present the law in this manner an attorney has been employed for each state and an editing attorney, as mentioned above. The book will open with a discussion of the economic principles involved in the legislation under consideration, as viewed by Mr. Foote. Then will follow the review of the laws and court decisions of the several states, together with some comparisons between the different states. If we may judge from the prospectus, the work will be exhaustive. No space limit was placed upon the several writers, further than that they should be as concise as possible, and the result is that the book will be in two volumes, covering some 2,400 pages.

Mr. Foote believes that natural monopolies and public works should be turned over to private companies instead of being owned and operated by cities and towns. He would make franchises perpetual and remove all restrictions from companies so far as possible. As a safeguard against corporate oppression Mr. Foote would have these industries under public regulation and would have their rates fixed by the state to yield a reasonable profit. If this profit should be exceeded the excess would be divided equally between the company and the municipality. More will be said regarding the book after it has been published; but it occurs to us that the editor of a work of this nature ought to forget for the time being that he has any opinions on this great question, or at least ought not to announce them in a book which purports to aim only to show what is, and not what ought to be. We trust that Mr. Everett, the editor of the strictly legal portion of the book, and his assistants, have done their work in a thoroughly impartial spirit.

INDIANA ENGINEERING SOCIETY. Twelfth Annual Report, Containing the Proceedings of the Society at its Annual Meeting at Lafayette, Ind., Jan. 12-14, 1892. E. B. Vawter, Corresponding Secretary, Lafayette, Ind. 8vo, paper, pp. 137, 50 cts.

The papers of principal interest in this report are those devoted to land drainage and land surveys. There is also a rather good discussion of highway improvement, and highway bridge construction. An excellent paper on "Strength of Vitrified Pipe" we reprint in another column.

TRADE PUBLICATIONS.

BRIDGE RAILINGS.—Belmont Iron Works, Philadelphia, Pa.; 4to., pp. 16.

This is an illustrated catalogue and price list of the company's standard designs for bridge railings, lamp posts, etc.

LOCOMOTIVES AND CARS.—Catalogue No. 15, A. S. Males & Co., Cincinnati, O., 16 mo., pp. 41.

The catalogue contains dimensions, weights, and other particulars of standard and narrow gage engines, and cars of all classes; steam motors, logging engines, turntables, bridge, steam shovels, ballast unloaders, etc.

ROCK EXCAVATING DREDGES.—Lobnitz & Co., Engineers and Shipbuilders, Renfrew, Scotland. 4 to pp. 13; illustrated.

This is a handsomely illustrated catalogue of pump dredges, floating cranes, and the Lobnitz rock breaker and dredge which was fully described and illustrated in our issues of Jan. 26 and Oct. 19, 1889. A 2-ton rock cutting ram for use on land is also shown.

THE UNIVERSAL CUTTER AND REAMER GRINDER. Providence: Brown & Sharpe Mfg. Co., 8vo., pamph., pp. 27, 25 cts.

The tool whose manifold uses are described in this pamphlet has been on the market for a number of years and has come into extended use. The fact that such tools are available makes the work of the builder of special machinery far easier than it was before their introduction.

SOCIETY PROCEEDINGS.

NEW YORK RAILROAD CLUB.—A meeting will be held at 12 West 31st St. on Sept. 15 at 7:30 p. m. Mr. Hugh Baines will present a paper on "Rolling Stock in Its Relation to Track" and Mr. F. A. Stinard, on "Boiler Scale and Purification of Feed Water."

WESTERN SOCIETY OF ENGINEERS.—The members of this society with ladies visited Jackson Park on Sept. 1 and lunched in the Mines building. Mr. Willard A. Smith, Chief of the Department of Transportation Exhibits, acted as toastmaster, and President Isham Randolph, W. L. B. Jenney, Gen. Wm. Sooy Smith and Prof. I. O. Baker were among the speakers.

COMING TECHNICAL MEETINGS.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Oct. 18. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Oct. 13. Secy., O. H. Landreth, Nashville, Tenn.
WISCONSIN POLYTECHNIC SOCIETY.
Sept. 13. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Sept. 12. Secy., C. L. Annan.
NEW ENGLAND RAILROAD CLUB.
Sept. 13. Secy., F. Curtis, B. & A. R. R., Boston.
DENVER SOCIETY OF CIVIL ENGINEERS.
Sept. 13. Secy., Geo. H. Angell.
NORTHWESTERN SOCIETY OF ENGINEERS.
Sept. 13. Seattle, Wash. Secy., F. H. Warner.
MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC.
Sept. 14. At Detroit, Mich. Secy., Robt. McKee, Kent, O.
NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 14. At Middleboro, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Sept. 15. Secy., C. F. Franson, 113 Adams St.
ENGINEERS' CLUB OF CINCINNATI.
Sept. 15. Secy., J. F. Wilson.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Sept. 17. Secy., F. D. Jones, Helena.
WESTERN RAILWAY CLUB.
ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 17. 1122 Girard St. Secy., L. F. Rondinella.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., R. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 21. Secy., F. Collingwood, 127 East 23d St., New York
CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Macbeth.
SWEDISH ENGINEERS' CLUB.
Oct. 1. Secy., P. Valentine. At 221 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Oct. 1. Union Station, St. Paul.
ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 19, 20, 21. Cleveland, O. Secy., Wm. J. Richardson, Brooklyn, N. Y.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 21, 22. Roanoke, Va. Secy., J. R. Schick, Roanoke.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., F. A. Cherpiot, Macon.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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VOL. XXVIII. THURSDAY, SEPTEMBER 8, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

SUBSCRIPTION RATES: one year, $5.00; 6 months $2.50; 4 months, $2.00; single copies, 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. Send both the old and the new addresses. No club rates allowed.

The date when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance. No other receipt is sent unless requested.

ADVERTISING RATES. 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The disposition which the Tilden trustees would make of the splendid foundation for a public library which the generosity of a relative still leaves to them, after more than half has been lost by legal quibbles, has been awaited with some anxiety. Mr. John Bigelow relieves this anxiety in the current issue of "Scribner's Magazine" by a careful and detailed sketch of, first, what the trustees wish to do and think best to do, and secondly, thirdly, fourthly and fifthly, what they will do if they cannot have their first choice. It will interest engineers to know that the "fifthly" is the foundation of a purely technical library in this city. Mr. Bigelow takes the view which we have often expressed that a really good technical reference library is one of the crying needs of this city, and one which at present is not being filled in any way. The Astor Library naturally occurs to one, but that library of some 230,000 volumes, weak in almost every department, is especially weak in its technical departments. Fully three-fourths of the standard works which are found as a matter of course in engineers' private libraries are lacking from its shelves. It is impossible to attempt to look up any, even the most trivial engineering question, in the Astor Library, without running up against a number of glaring deficiencies. Nor is there much prospect of any improvement in this respect, because the Astors do not and other people will not give the library sufficient funds to make it an honor to the city. Similarly the libraries of the American Society of Civil Engineers and other small collections of the kind, while containing many valuable works, is hardly even a beginning toward a useful working library of modern technology. Mr. Bigelow is right in thinking that, if it is not possible to get outside aid toward a site and building for the new library, it is much better to cover well a neglected and growing department of knowledge than to add another to the numerous existing libraries which by attempting to cover the earth, really cover nothing.

But Mr. Bigelow's preference is to attempt to cover the whole field of literature with some aid from the city, trusting to a liberal public to appreciate and support a good beginning. He proposes in a word that the city shall condemn the old 42d street reservoir, as no longer needed, throw the site into Bryant Park, more than doubling its area, and then erect for the trustees (or at least give them material in the old reservoir for) a thin cruciform building covering about one-fifth of the total area of the park only and in effect cutting it into four small parks. This done, the entire income from the Tilden funds, some $80,000 to $100,000 per year, can be devoted to managing and increasing the library, which can grow to over 1,000,000 volumes, or more than the library of the British Museum now contains, before the capacity of the building is exhausted. Then (although Mr. Bigelow does not say so) business will have so encroached upon the surrounding district that large park space will be less important, and the building can be further extended, to hold 10,000,000 or more volumes, without occupying all of the site.

The advantages offered by this plan are very evident, its disadvantages are in comparison insignificant. The site is an ideal one; the building and contents would be the ornament and pride of the city. The possibility of indefinite and great future expansion on the same site is a rare and important advantage; it might well end in a second British Museum. Gifts and legacies would flow in rapidly to such a library thus placed, as they would not flow in to it on an inferior building and site; the site would be an earnest that the whole city took an interest in it. The immediate effect of the improvement would be to increase and not decrease the park area of the city, which beyond doubt needs increase. New York has so far been sadly behind in that great necessity of a true metropolis, a good reference library. Granting this site to the Tilden Library would take away this reproach as it will not be by permitting the trustees to found a relatively weak institution on some obscure site which they can afford to purchase.

The only objections which can be made to this course are (1), that the city cannot afford to give away such a valuable site for this use; (2), that it is needed to increase the scanty area of our small parks; (3), that the reservoir itself is still needed as a part of the city water-works. The first objection no man urges. The second is of admitted force, but is sufficiently answered by the fact that the immediate effect of the measure is to nearly double, instead of decreasing, the area of Bryant Park. The third may possibly be made a handle of by the politicians to escape from the necessity of turning such a plum as this to the "damn literary fellers," but how little there is in it is evidenced by the fact that the reservoir only holds full about 24,000,000 gallons, or 4 to 5 hours' supply for the city, about 1-56th part of the Central Park reservoir capacity, which is intended to hold enough to last a fortnight or so in case of need. The old reservoir does perhaps, have a certain utility as an equalizer of pressure in case of any sudden demand for water, besides being another drop in the bucket of storage capacity; but these ends are not even important, still less essential, if there is a better use for the area. We earnestly hope that the site will be granted for the library. It is the best possible use of it from every point of view.

We illustrate in another column a system of traction for railways operating on steep grades which has the interest always attaching to a novel and ingenious principle, besides which it seems to promise enough of practical utility to be worth a careful examination by engineers engaged in this class of work. The steepest grade which can be safely operated by ordinary systems of steam or electric locomotive traction, is from 8% to 12%. Where steeper grades are to be surmounted or if the grade is much lighter than the above rates and is very long, some other system of traction is essential to safety and economy. Thus far the engineer has had to choose between two systems for such steep or long grades, cable traction or some form of rack-railway, for old forms of friction grip railways on the Fell and other systems have not been very successful. Both cable traction and the rack-rail system have their well established limits. The former is well suited to working steep inclines of moderate length, which can be built on a tangent or nearly so. The rack-rail system is of much more general application and can be applied to railways part of whose length is not fitted with the rack-rail. The Van Zile automatic grip traction system described in another column, while originally designed for working steep grades on electric street roads, seems to be adapted to compete with the rack-rail system for mountain railways. It has the manifest advantage over the rack-rail system that its traction rail can be rolled and does not require to be built up; hence it should be much cheaper than any form of rack. The fact that the traction wheels in the Van Zile system are horizontal instead of vertical may make it somewhat difficult to connect the steam or electric motor to them; but if this can be successfully done, there is no apparent reason why it should not take precedence of the rack rail system for mountain railways. Perhaps it may also so cheapen the cost as to give something of an impetus to their construction. The method of obtaining the desired gripping force automatically, varying with the tractive force exerted, and hence with the grade, is quite novel, we think, and certainly ingenious, with the added interest that it was designed by Mr. Van Zile while an undergraduate at Troy, from theoretical premises only, which were found to work out in practice as expected. For realizing the advantage claimed for the old system of easy change from rack to adhesive propulsion and vice versa, the Van Zile grip may possibly prove to have decided advantages.

A suggestion for ending or lessening wholesale labor contests, which is at least somewhat novel, and which seems to have some strong arguments in its favor, is made by Hon. Chauncey F. Black, in this month's "Forum," as noticed in another column. While the suggestion is merely in outline, and the details would necessarily involve many elements of difficulty, and possible mistake, it seems to us as likely to meet the changed relations of capital and labor, which we sketched last week, and as likely to bring peace between them, as anything which has yet been suggested. The proposal is, in brief, that "a new class of corporations in the interest of labor be invited and encouraged in American states, these corporations to be required to have a certain reserved capital, formed by the deduction of a certain percentage of earnings, under fixed conditions, so as to be answerable in damages for breaches of contract, and to have for their function to contract to furnish labor of a given kind for a given time at a given price, leaving it open to employers to employ such labor or that of dissociated individuals as they pleased, but not leaving it open to them alternately to recognize or ignore the existence of an organization among their workmen, as might suit their immediate interest or pleasure. The idea is that if an employer contracted with such a corporation for its labor, he should have no personal dealings whatever with the men, except to reject those that were not up to contract, as he might reject culls from a lot of ties; that the corporation should collect the wages in gross and pay dividends like any other corporation to its stockholders; admitting or dismissing from membership; suing or being sued; collecting damages or paying them; prospering or not prospering, according to the quality of its management, like any other corporation; thus adding to the present labor unions the important element of financial responsibility and loss for breaches of contract, and of possible failure from lack of sales if it had not a good article to sell, like any other corporation.

Mr. Black sees only two objections to this measure, that the corporation might not be financially responsible, and that its membership might be fitful and shifting, both of which he rightfully dismisses as unsound. But there is still another more serious objection, that it necessarily involves the abandonment or limitation of the employer's present right of arbitrary discharge. As under any other contract for buying or selling, the buyer of labor from such a company could be permitted to cull out and reject only such parts of the goods delivered as were not up to specifications. He could not be permitted to cull out arbitrarily, without making the contract itself a farce. Now, every large or small employer of labor knows that a man may make himself a burden and offense to an employer without committing any act which could be explained in words before a third party as sufficient grounds for discharge. And to have to give any reasons to any party for any number of discharges would be a bitter pill to many employers, not wholly without reason. For a time at least, until habits and customs had readjusted themselves, more or less friction would result.

Nevertheless, such a scheme as that outlined necessarily implies some judicial method of settling disputes as to the quality of the goods tendered, and the only feasible way, it seems to us, would be to

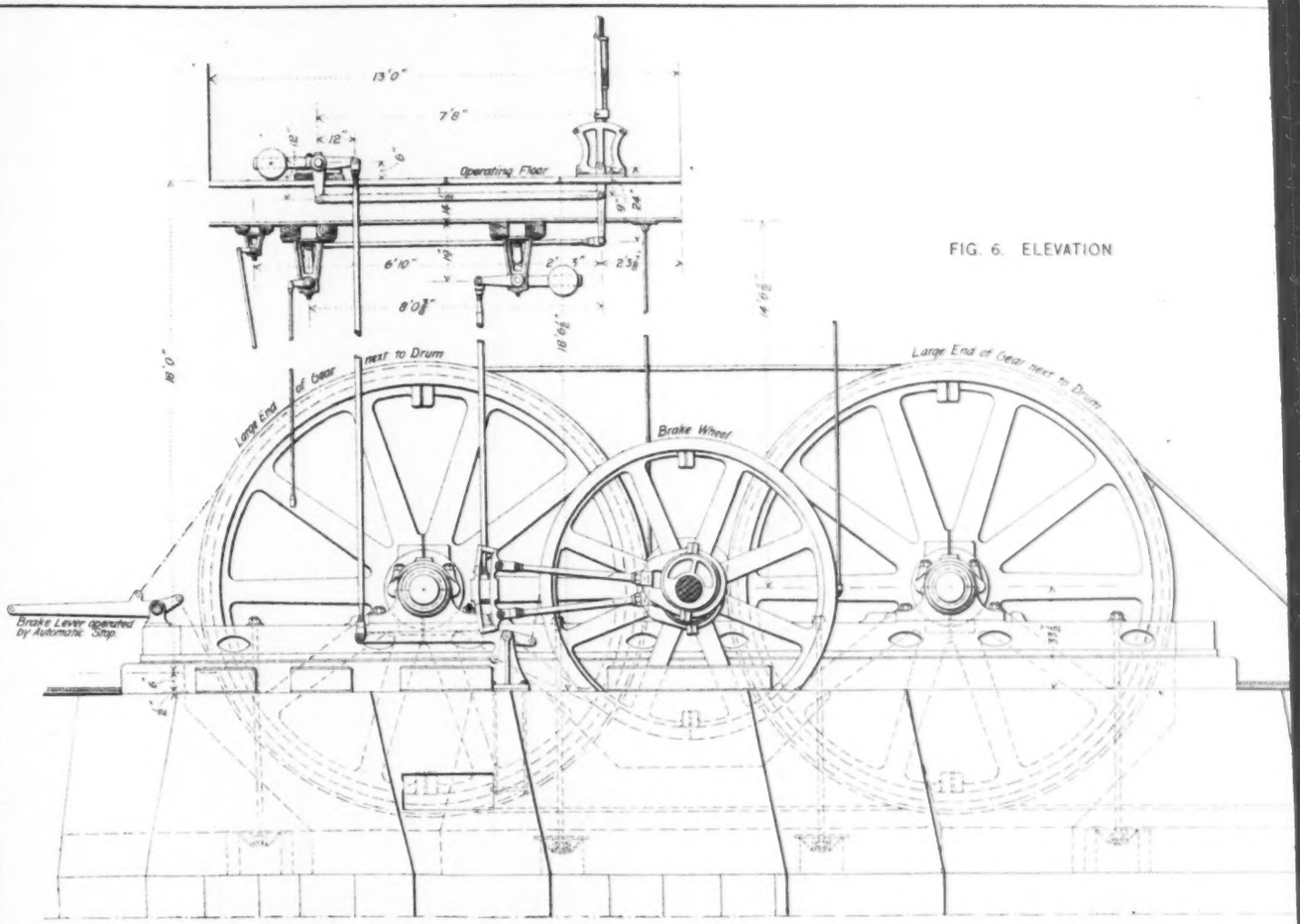

FIG. 6. ELEVATION

Hoisting Machinery.

The Walker Manufacturing Co., Cleveland, O. Manufact

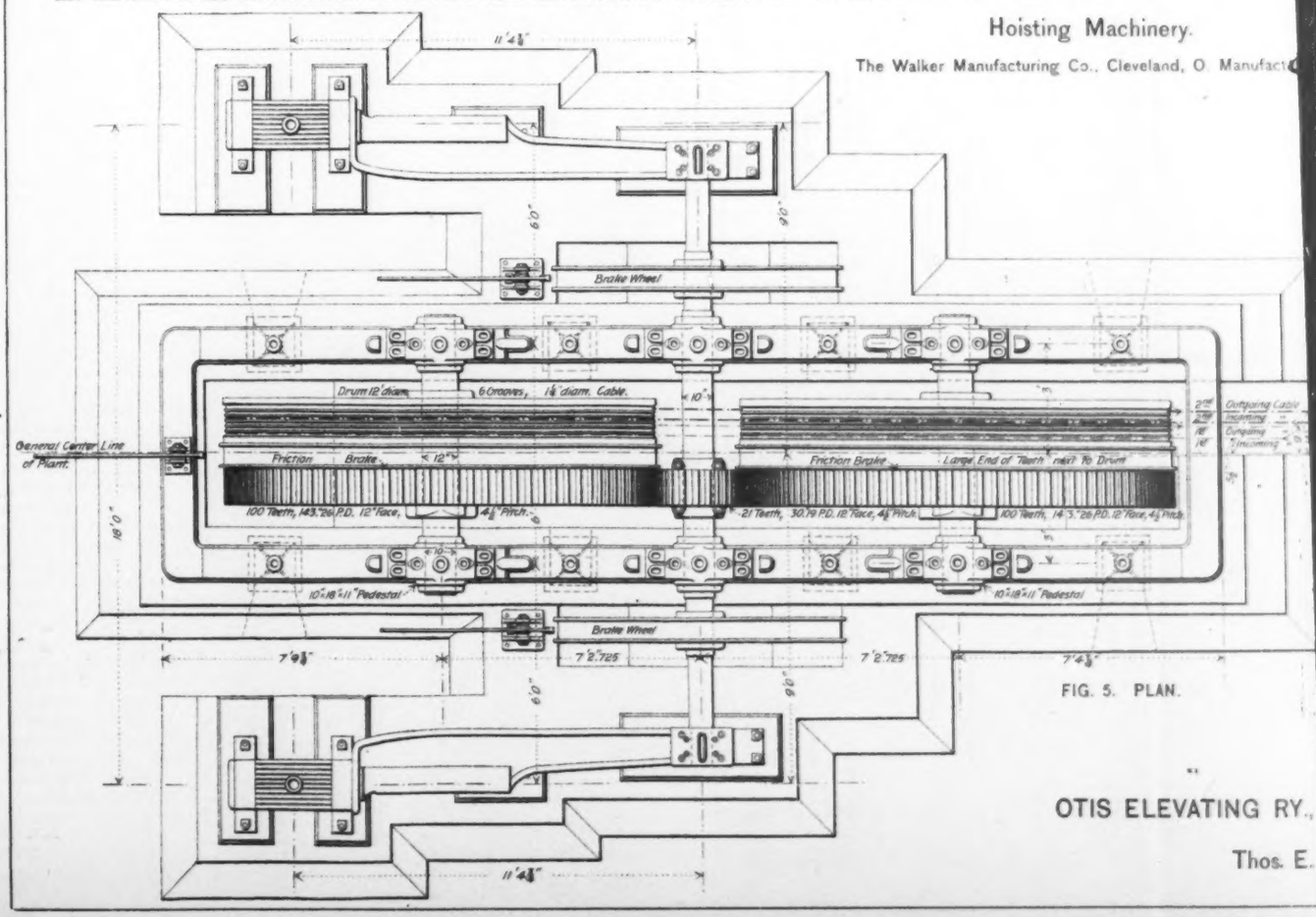

FIG. 5. PLAN.

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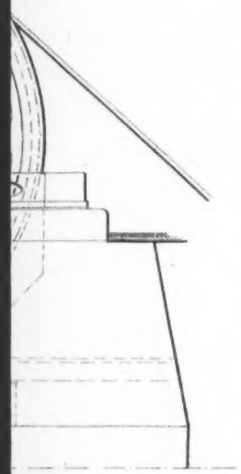

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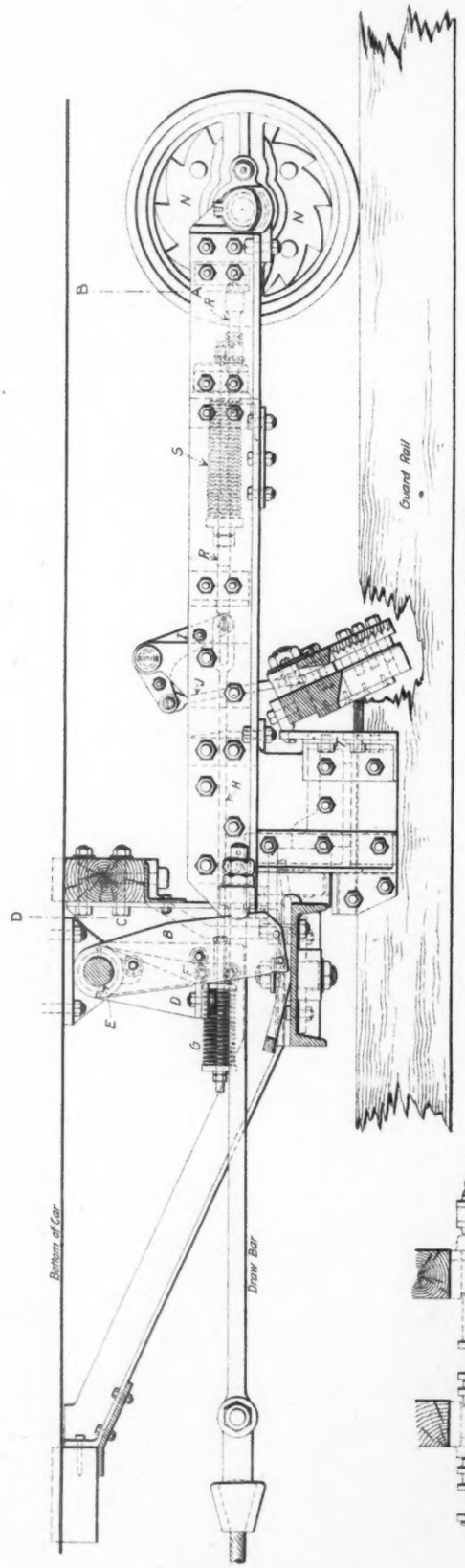


FIG. 7. ELEVATION.

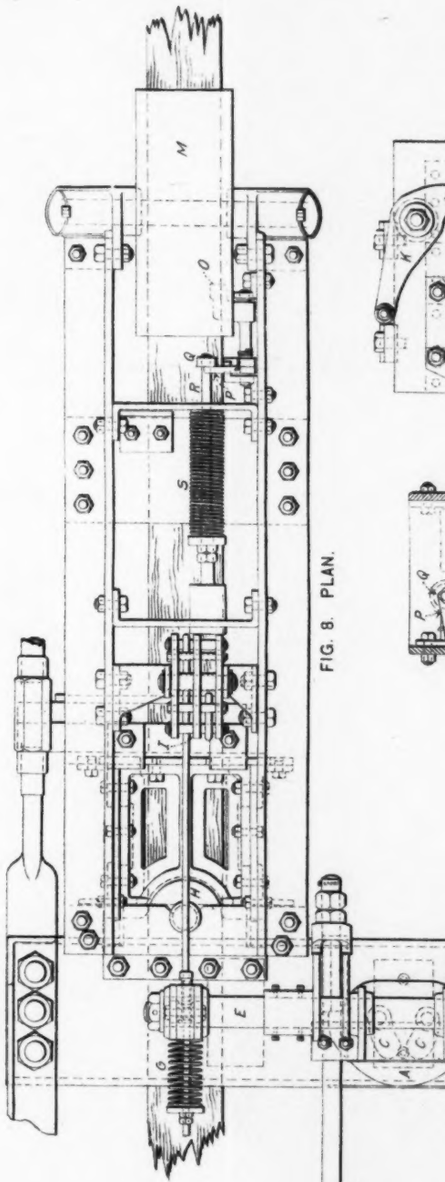


FIG. 8. PLAN.

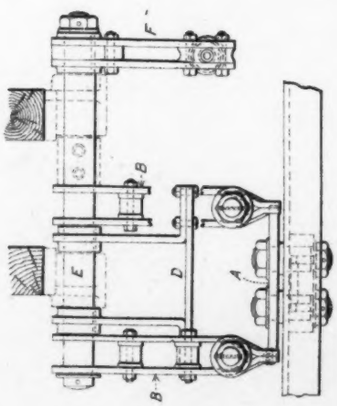
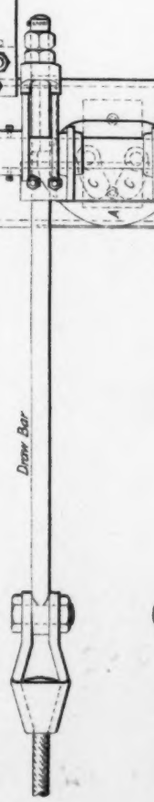
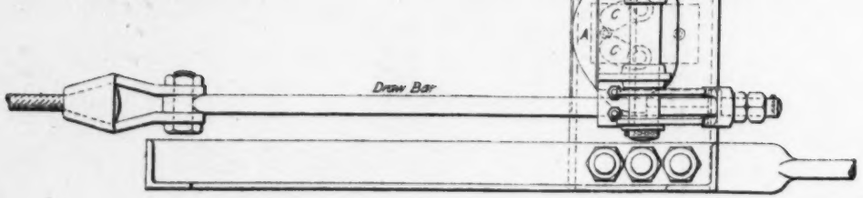


FIG. 11. REAR VIEW, C D



EVATING RY., CATSKILL MOUNTAINS, NEW YORK.

Thos. E. Brown, Jr., Chief Engineer.



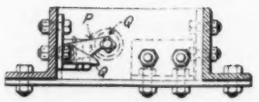


FIG. 10. SECTIONAL VIEW, A. B.

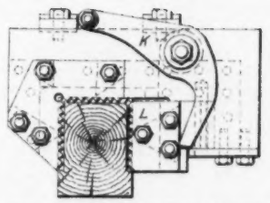


FIG. 9. TOP VIEW OF CLUTCH.

Safety Clutches.

Otis Bros. & Co., New York, N. Y., Manufacturers.

imitate one feature of our jury practice by giving to the employer the right to a certain number of peremptory discharges, with the future right to an unlimited number of discharges for cause, as determined by some simple process before a specified and mutually accepted tribunal. Even this involves a change which will be grievous to many; but some change of this nature seems to be demanded by modern conditions. If it is a necessity of industrial peace, the sacrifice should be cheerfully made. With this difficulty well provided for we see no reason why Mr. Black's suggestion is not worthy of attention and of trial, though we should hardly expect that the first attempt in that direction would give satisfaction to either side.

WOOD AS A PAVING MATERIAL.

For many years wood paving may truthfully be said to have had no recognized standing among American engineers. It has been regarded as a cheap makeshift, whose use was permissible only until something better and more permanent could be afforded. As it has been laid in the United States it is almost invariably true that, notwithstanding its small first cost, the rapid deterioration has made it a very expensive pavement.

With much of the wood paving which has been laid in European cities a similar experience has been recorded, but on the other hand with the adoption of better methods in the laying of wood paving it has grown in favor in several foreign cities and, especially in London, it is now competing even with asphalt in popularity. Doubtless every American engineer who has spent much time in English or Continental cities has been convinced that either the cities or the engineers of his native land could copy foreign practice in the matter of street pavements to much advantage. The invariable tendency of the European and especially the Englishman to look for solidity in all his construction operates nowhere to greater advantage than in street paving, where the best is none too good and (except where rates of interest are exceptionally high) is found to be the cheapest in the long run.

One marked feature in which European practice has been in advance of American is in the provision of a proper foundation for paving of every sort. Millions of dollars have been spent in American cities in laying good paving materials on a soft foundation, and the result has commonly been that the street became a succession of hills and hollows under the wear of traffic.

Now one of the cardinal principles of road making and maintenance is that the smoothest surface not only offers least resistance to traction but wears the least. As soon as a depression is formed in a road, every wheel which drops into it gives it a blow which tends to deepen it. A wheel rolling over a perfectly smooth surface cannot strike a blow or exert a shock; but a wheel rolling over a rough block pavement of any material delivers a series of blows on every depression in its path. For this reason a large outlay in the original construction of a pavement is justifiable if by it a smooth pavement is secured. According to the modern theory of paving, the stone, wood, or asphalt is only a wearing surface, and the concrete foundation, which covers the whole street, is relied on to support the weight of the vehicles which travel over it and to prevent inequalities in the wearing surface, except such as occur from its unequal abrasion.

We need hardly say that wood pavement conforming to the modern theory of street pavement construction has seldom been laid in this country. The usual practice has been to grade the dirt in the street to somewhere near the specified cross-section; perhaps it is rolled, perhaps it is not. On this is laid one or two courses of inch boards, or a layer of sand may take their place, and on this so-called foundation pine or cedar blocks are laid with spaces between them an inch, more or less, in width. But the blocks are not always rectangular. On the wood paved streets of Detroit, for instance, the blocks are round, made by sawing small tree trunks from 4 to 8 ins. in diameter into short lengths. Under the wear of traffic the exposed ends of these blocks take on a curved form, the edges wearing off faster than the center. The same thing is true of every wood pavement laid with open joints, though in less degree. This is one cause of unequal surface; but the more important cause is the unequal settlement of the earth underneath, and the decay of the boards and blocks.

In the early days of wood paving in London, boards were laid underneath the blocks, but experience soon showed that this was a mistake and that a smooth, unyielding surface was the proper base for supporting them.

A concrete foundation is now placed under wood as under asphalt or stone. The blocks used are sawed to even sizes, usually about 9×6×3 ins., and are laid on edge in courses running at right angles to the street. It has usually been considered necessary to leave an opening of ⅛ to ¾ in. width between the courses, which was filled with cement; but considerable areas have been paved with the blocks laid close together, and it has been found that this pavement wears better and is smoother and less noisy than the pavement laid with cement joints. It has been generally supposed that the open joint was necessary to give a foothold for horses, but experience seems to show that friction between the shoe and the wood is the real reliance for a footing, and that the smooth, close jointed pavement, which can be kept cleaned of greasy dirt is not more slippery than the pavement laid with cement joints. Some of these close-jointed pavements were laid in the vestry of St. Marylebone as long ago as 1883, and the fact that the system is still followed there is good evidence that it has given satisfaction. Even so long ago as 1881, in a discussion on a paper by Mr. Geo. H. Stayton,* before the Institution of Civil Engineers, on wood paving, the fact was brought out that the narrower the joints of wood pavements the greater was their durability, and the smoother and more noiseless the roadway. Indeed one speaker said he had been told by omnibus drivers that if the wide jointed pavements were in universal use in London streets there would not be a driver without a spinal complaint at the end of a twelvemonth.

The durability of wood pavement when properly laid on a substantial concrete foundation depends chiefly on the ability of the wood blocks to resist wear and decay. Wood from coniferous trees has been generally used in London, as it resists decay better than the harder and more durable woods, and wood preservative processes have not seemed to meet with favor as applied to wood pavements. The wear of ordinary pine blocks under a traffic of 750 tons daily per yard of street width may be taken at 0.15 to 0.30 ins. per annum, according to Mr. Stayton's statistics, while the total life of the wood blocks is from six to nine years.

Within a few years a hard wood from Australia, known as jarrah, has been introduced in London for paving purposes, and its wear has proved to be much less than that of the softer woods. It has been laid without creosoting or preserving in any way, and experience of over three years has shown it to be very durable. In a recent editorial article "Engineering" said:

> We are entirely of the opinion that the future of jarrah pavement will be shallow blocks laid tightly together so as to eliminate the joints as far as it is possible to do so, also that no satisfactory results may be expected from the use of a smooth surfaced, noiseless pavement if a wide jointed system be adopted. It is probable that the depth of the hardwood block may in the future be reduced to 3½ ins., perhaps slightly less, and continue to make a good road surface, for the average depth to which pine pavements are allowed to wear down in London is below 3 in., in many cases it wears to 2 ins. and even to 1½ ins. When first laying jarrah blocks, now over three years, Mr. McIntosh kept the wood surface ¼ in. above all iron fixtures in the road, but the wear of the wood has proved to be so very slow that practically the original depressions above the irons remain in the roadway; so he decided to alter his system and is now laying wood almost flush, raising it above iron from $\frac{1}{32}$ in. to ⅛ in.

The main reason why wood pavement has grown in favor in London in competition with asphalt, which is also extensively used, is found in the peculiar climate of the city. Asphalt pavement when dry or when thoroughly wet by a rainfall gives a secure footing; but when merely moistened by a London fog it is so slippery as to give rise to many accidents to horses. Wood, however, when frost follows damp weather is a very slippery pavement, and in London streets it is necessary to sprinkle it with sand at frequent intervals in frosty weather. It might be, therefore, that in the Northern cities of the United States wood would prove a more slippery pavement than asphalt. In London the general opinion of the managers of the leading cab and omnibus companies seems to be that wood pavement is better than asphalt. One company, however, states that falls were most frequent on asphalt in summer and on wood in winter; another is reported as saying that a great advantage of asphalt over wood was that it lasted three times as long, hence the traffic was less frequently interrupted on account of the renewal of the pavement. The result of opinions collected from about 1,200 cab and omnibus drivers in answer to the questions: "Which do you consider the best form of roadway to drive over?" and "Which is the worst?" was as follows: 750 men considered wood the best, and 51 considered asphalt the best; 122 considered wood the worst and 1045 thought asphalt the worst. Another bit of evidence as to the relative merits of wood and asphalt paving is that asphalt paving was recently ordered to be laid in place of wood on several London streets on the recommendation of Col. Haywood, City Engineer, whose investigations into the relative values of the two pavements have been most thorough. At a meeting of persons interested in street traffic, including representatives of cab, omnibus and express companies, a resolution was passed by a vote of 28 to 12 protesting against the adoption of asphalt. The fact that so considerable a minority voted against the resolution leads one to suspect that some part of the opposition to asphalt may be the result of prejudice and conservatism. The tendency of public opinion to magnify the defects of any innovation on common practice is something which engineers have frequent occasion to notice.

The cost of wood paving abroad is, of course, not much guide to its cost here; still the figures may be of interest. The cost per sq. yd. for covering a concrete foundation with 6-in. pine blocks untreated is about $1.44; 5-in. creosoted blocks cost about $1.80 per sq. yd. The Australian jarrah blocks, 5 ins. deep, cost, laid, about $2.40 per sq. yd.

Concerning wood paving in this country, every engineer will admit that no success can be looked for on the lines which have been followed here in the past. If there be any future for wood as a paving material in this country, it must be sought through the use of a permanent concrete foundation, and it seems probable, through the use of some of the harder varieties of wood, discarding the soft and rapid wearing timber which has heretofore been used.

The abundance of hard woods in this country is such as to give some ground for hoping that a wood for this purpose can be found as durable as the Australian timber has proved in London. We have already noted some reasons for believing that wood paving might be less successful in this country than abroad. But, on the other hand, two reasons are suggested why wood paving in American cities might have advantages over asphalt. The great range of temperature between summer and winter in our Northern cities makes it difficult to lay an asphalt which will endure the severest cold without cracking and yet will not soften so as to take hoof prints and wheel marks on the hottest summer day. Again, the rapid growth of American cities necessitates a great amount of tearing up of streets, and wood blocks can be replaced with rather less injury than asphalt when a street opening is made.

* Reprinted in Engineering News, vol. xii., p. 242.

INVENTORS VS. BUYERS OF THEIR INVENTIONS.

The outcome of the suit for breach of contract between Mr. Thorsten Nordenfelt and the Maxim–Nordenfelt Guns and Ammunition Co., Ltd., contains a moral that is worth noting by corporation lawyers who seek to secure the earth for their clients. The case is this: Mr. Nordenfelt, in 1886, sold his business to the Nordenfelt Guns and Ammunition Co. which afterward consolidated with the Maxim Co. He bound himself, among other things, for a term of 25 years, not to engage directly or indirectly in any competing business in the manufacture of guns, gun mountings, or carriages, gunpowder, explosives or ammunition, and he was to hand over to the company the full and exclusive benefits of any new invention or improvement "now made or discovered, or that may hereafter be made or discovered by him," in connection with the field of manufacture outlined above. This agreement applied to the whole world as far as area was

concerned, and Mr. Nordenfelt accepted the position of managing director for seven years and signed the agreement.

But differences arose and in January, 1890, Mr. Nordenfelt was compelled to resign and later he connected himself with the Société Cockerill in the manufacture of quick firing guns. He claimed that the agreement was rescinded by the company when they superseded him in his important office, but the company thought differently and brought an action for an injunction. Justice Romer in his opinion of Aug. 9-11, ruled that "the period of 25 years, without any restrictions as to space, was beyond what was reasonably necessary for the protection of the company, and that the clause, being unjustifiable in restraint of trade, was void as against the defendant." The company thus lost its case as against Mr. Nordenfelt going into business for himself, and the question of the ownership of the present and future patents is now to be decided.

Our English contemporary, "Engineering," in commenting on this case from fuller data than are in our possession, justly says that the entire case shows the danger of those widely sweeping agreements that lawyers are so fond of drafting. Under the articles of association the Maxim-Nordenfelt Company was enabled to enter into the business of shipbuilding, tool-making, electrical engineering, colliery plant, etc., and to practically restrain Mr. Nordenfelt from engaging in any of these lines within the limit of time or area stated; or, it could at least, compel him to relinquish such business whenever it pleased the company to enter into it.

This sweeping agreement was doubtless thought to be clever agreement-making, but it was shown to be bad law. The company paid Mr. Nordenfelt nothing for the right to build ships, etc., and hence could not reasonably impose the conditions named. And while the gun company could properly claim the civilized world as a field of action, the time fixed in the agreement was much too long for that area. In less than half 25 years, at the modern rate of progress in guns and their ammunition, entirely new conditions and methods would be created, and practically to retire Mr. Nordenfelt for that length of time was to render useless his previously acquired experience and knowledge. The agreement amounted to a practical retirement, for it seemingly was not dependent upon Mr. Nordenfelt's personal permanent connection with the company, and only obligated him to keep out of business for himself and to turn over any new inventions of his without any further reward than the original compensation.

The transfer of the probable inventions is a common practice in such cases, and in itself is just to the purchaser, as it prevents the seller from patenting for himself a new process or invention that may entirely supercede the one sold. But the usual practice is also too often lacking in certain essential conditions, and tends to stop improvement by the original inventor. New inventions of value generally cost much time, trouble and expenditure of money, and if Mr. Nordenfelt, for example, were to feel that all this was to be expended without any farther gain to himself, it would be natural for him to seek some better paying field for his inventive talent. To secure the full value of the possible services of an inventor he must be personally and directly identified with the gains from his future work, and share in the profits of his later inventions, by a stock interest or otherwise. As seen in the case here quoted, an inventor and his inventions can not be safely separated.

The relative merits of single screws and twin screws for steamships were referred to in our issue of Aug. 11 and 25, in commenting upon the recent fast passages of the single-screw steamer "Umbria" of the Cunard Line. The recent performance of the twin-screw steamer "Scot," of the Union line, running between England and South Africa, points out the advantages of the twin screw arrangement in case of a breakdown. According to the "Engineer," of London, the "Scot" left Southampton on June 11, and on June 12 the high-pressure cylinder cover broke, but the captain decided to go on to Cape Town with one engine. In spite of unfavorable weather, the trip was made in 18d. 4h. 53m., at an average speed of 13.4 knots. The daily run was from 295 to 344 knots, the latter giving a mean speed of 14.3 knots. The contract time for carrying the mails to Cape Town is 20 days, so that the passage was a successful one, and the delay and inconvenience of putting back to port and transferring the passengers were avoided.

LETTERS TO THE EDITOR.

PILE FORMULAS AND BEAMS.

Sir: For more than a quarter of a century I have subjected piles to a load of 10 tons per pile, the piles being driven by a hammer weighing a ton falling 10 ft.; the driving being stopped when the pile would not go more than an inch at a blow.

Your formula fills the bill precisely, giving exactly 10 tons as the safe load for such a pile. Molesworth gives one half more as the safe load, but naively adds "approximately." H. Rankine's formula is an enigma.

Have you any good rule for the strength of beams built of wood. Rankine, Molesworth and Trautwine say that built beams are nearly as strong as solid ones. This is not satisfactory. In many districts timber can be used with economy and dispatch.

Yours faithfully, C. E.

Sackville, N. B., Sept. 1, 1892.

(We have nothing novel to advance in the way of formulas for the strength of wooden beams. If those in Trautwine are not trustworthy enough for practical use we have not detected the fact. We should distrust anything not of a theoretical nature in Rankine and Molesworth, as their records of facts of experience are now antiquated, especially for American practice. The built beams to which the authorities quoted refer are built up laterally, not vertically. For such beams the statement is substantially accurate, but if applied to beams built up in horizontal layers, it would be quite inaccurate.

The pile-driving formula referred to first given and explained in our issues of March 6, May 11, 1889, was:

$$\text{Safe load} = \frac{2\,w\,h}{S+1}$$

Substituting the values given above (which saves us the necessity of defining the values of the letters) we have

$$\text{Safe load in tons} = \frac{2 \times 1\,(\text{ton}) \times 10\,(\text{ft})}{1\,(\text{in.}) + 1} = 10 \text{ tons.}$$

We shall shortly have some further information to give in regard to this formula, which we can still recommend as the most trustworthy as well as the simplest in existence.—Ed.)

A QUESTION OF MONUMENTS

Sir: Permit me to call your attention to what I think must have been an oversight on your part in answering R. L's question, relative to location of a boundary line, in your issue for Aug. 25. You say: "If the stone monuments at f, d and e were set by the U. S. Surveyors, they will govern, we think," etc. I think you overlooked the preliminary statement that the line in question runs "through the center of a section," for you must be aware that the U. S. Surveyors did not set any stones or mark any corners inside the exterior boundaries of any section, and, of course did not set any stones at d. If the stones at f and e are at the quarter section corners, as located by the U. S. Survey, then the quarter section line must be a straight line between those two points. There is no exception to this rule of law. The adjoining proprietors may have settled in a different boundary line by agreement, or by adverse possession. Otherwise, if their deeds are bounded on the quarter section line, their line must run straight from f to e.

Yours truly,

Climax, Mich., Aug. 27, 1892. F. Hodgman.

(Our correspondent is correct in a measure at least. Our "if" supposed an impossible case under the general rules of the U. S. laws for primary land surveys; but to those rules there are a number of exceptions for special cases, and "if" the monument d had been in fact set in a lawful way by U. S. surveyors, even if they were not actually required to do so, it would govern; would it not? If it be true that under no conceivable circumstances the point d could be thus set, we were not aware of it.—Ed.)

WANTED, A POROUS PAN.

Sir: I wish to make use of some pans several feet square, with bottoms very porous, like unglazed earthenware. The pans must not be brittle, so earthenware will not answer the purpose. Can you, or any of your readers, tell me of some material fulfilling these requirements? Very respectfully, F.

Blacksburg, Va., July 30, 1892.

(For a few dollars each, filters made of spongy volcanic basalt in the form of an inverted hollow pyramid about 2 ft. square at the base and 3 ft. high, can be imported from Mexico, and might answer the unstated purpose. These filters are there in universal household use, as they deserve to be everywhere. They are cut out of the solid, with sides about 2 ins. thick, and have been made and used from remote antiquity, we believe, like the "matates" on which corn is ground by hand. Both are cut from the same kind of stone, which exists in vast quantities in Mexico. The function of the filters is not only to purify but also to cool the water filtered. It oozes through to the lower side so as to keep it constantly wet, and to maintain a pretty rapid dropping of water from the apex, where it falls into a large jar. The evaporation keeps all the water in the jar nearly as cold as ice-water day and night. The filter is placed in a high latticed stand with a door at the bottom to give access to the jar.

On another page of this issue we give drawings of a filter plant used at Worms, Germany, the porous pans in which might serve the required use.—Ed.)

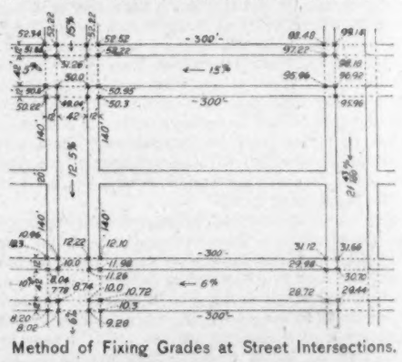
FIXING STREET GRADES.

Sir: I read with interest the article in Engineering News of Aug. 25, entitled "Fixing Street Grades," and the editorial note in response thereto.

I observe that neither the sketch nor your expressed opinion are strictly in keeping with the report of Rudolph Hering and Andrew Rosewater, consulting engineers to the Board of Public Works, of Duluth, Minn., bearing date of March 7, 1890. Said report, in answer to the question as to "Outline sections of streets and alleys best adapted for steep hill sides; also plans of several street intersections on steep gradients," reads as follows:

"The sectional forms of streets, avenues and alleys at intersecting points are more or less dependent upon the grades, and upon the relative proximity to the business or residence sections of the city. At the intersection of avenues with streets in the business portion of the city, the limit of gradients for crossings must, for obvious reasons, be less than upon streets in the residence portion. In both cases, however, certain prescribed limits of form are essential to the requirements of traffic and drainage. These limits are fully shown on the drawing accompanying this report. Briefly summarized they are as follows:

"Upon all streets and avenues in the city, except in the business section, the curb grades should be unbroken between intersecting curbs. In the business section of the city the lines of curb grades, when exceeding 8%, should be broken at the street or property line. All street crossings from the curb on one side to the curb on the other, irrespective of location, should be designed on the basis of a 3% slope, except when the slope of the intersecting streets or avenues is less, in which case the grades shall be continued unbroken over the crossings. In determining the height of the block corners, the elevation of the curbs at the two



Method of Fixing Grades at Street Intersections.

opposite points should be added to the rise of the two walks from their respective curbs to the corner, on the basis of 2½% inclinations, which sum divided by 2 will give the desired elevation. In other words, the block corner shall have an average of the elevations determined from the two opposite curbs after allowing the usual rise in walks of ¼ in. per ft. across their width. Upon steep grades, to facilitate the entry of vehicles to the alleys, made difficult by the side slope of the avenues, it will be best to reduce the alley width across the sidewalks from 20 ft., their present width, to 10 ft. After allowing for 1 ft. slope across the remaining 10 ft. of the alley, increase the grade of a portion of the curb and walk on each side of the alley opening, and, if necessary, provide steps. These features are more clearly outlined in drawings accompanying this report. Without these provisions the entry to and from the intersecting alleys from steep avenues would be somewhat hazardous."

The remainder of the report relates to something else, aside from grade lines, so I will quote no more.

The above, from Messrs. Rudolph Hering and Andrew Rosewater, seems to me to be the best solution of the ever troublesome question which arises in municipal engineering, which is, What is the best form of a street intersection? If there are other forms which have met with general satisfaction by city engineers, I, for one, should be very glad to hear of the same.

X.

Battle Creek, Mich., Aug. 27, 1892.

(We agree with our correspondent that this seems to be a very carefully drawn up scheme for dealing with the difficult problem which greatly affects the appearance of the streets, if it does not their utility. If there are any other rules of the kind established in any city, we should be pleased to publish them.—Ed.)

FILTERING PLANT, "SYSTEM FISCHER AND PETERS," AT WORMS, GERMANY.

The main feature of this new filtering plant, and a somewhat novel one, is the use of filtering slabs composed chiefly of sand. By employing these the filtering surface may be increased about tenfold within a given area. The following description of this new plant we abstract from the "Zeitschrift des Vereines Deutscher Ingenieure:"

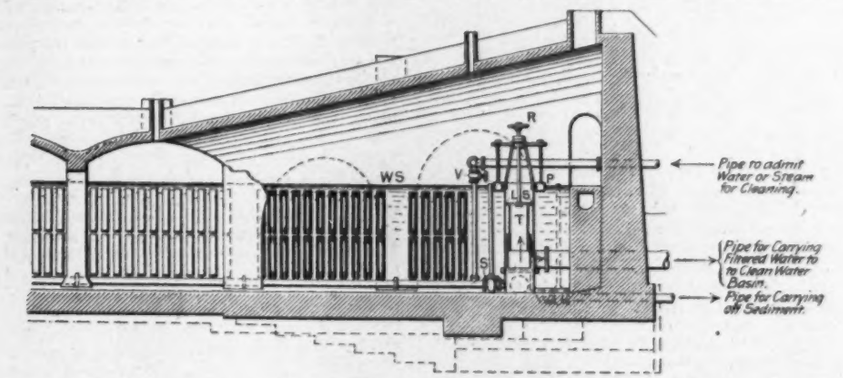
For the manufacture of the slabs clean river sand of uniform grain is mixed with a certain amount of silicate of lime and soda. The slabs are baked in ovens of peculiar construction to a great degree of hardness, while still retaining the porosity of the original sand. Each slab is 3½ ft. × 3½ ft. × 4 ins. thick. These slabs are slightly hollowed on one face, so that they resemble flat pans with a slight depression 25-64 in. deep, measuring 10.8 sq. ft. Two of these slabs are connected by their flanges, with the hollow part inside, the whole forming a block with a hollow space of 10.8 sq. ft. area and 25-32 in. wide inside.

The construction and arrangement of the complete plant, employing about 310 of these compound slabs, are shown in the accompanying plan and section.

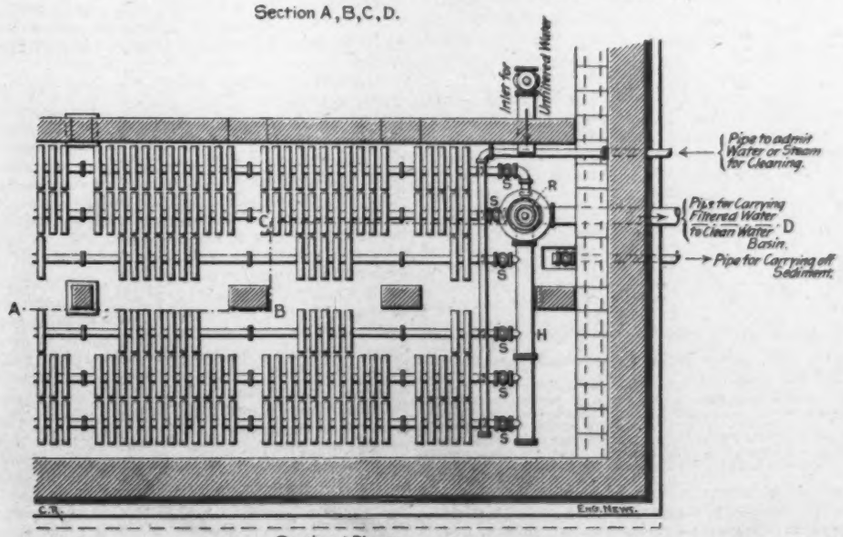
Two of the compound blocks thus obtained are placed on edge above each other, and all are completely immersed in the water to be filtered. This water percolates through the slabs from the outside to the hollow space inside, whence it passes into a valve S and opening valve V of one line of pipe, while the rest may remain in operation. The water admitted from the conduit is then passed through the slabs in a reversed direction, cleaning the filters of accumulaed filth. The deposit is precipitated and passes out through the mud pipe. For the purpose of sterilizing the filtering slabs, water is shut off and live steam admitted.

It is stated that the water filtered by this method contained from 184 to 200 germs of four different species per cubic centimeter against 2,400 to 2,700 germs, representing 30 species, for the same volume of unfiltered water.

The original article states that these numbers of germs were all that occurred per cubic meter, which if true would make them 1,000,000 times less frequent than the above, but we presume our contemporary erred in using "cbm." by mistake as an abbreviation for "cubic centimeter."



Section A, B, C, D.



Sectional Plan.

FILTERING PLANT AT WORMS, GERMANY.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXI.

Length of Course.

The subjoined Table XX, shows in detail the length of the course of 60 engineering schools in years, weeks per year and total weeks. The number of weeks per year is somewhat uncertain in a few instances, varying slightly with the courses chosen, but the differences are not material and will in part appear in a following article, giving the distribution of time to the various studies.

Though covering directly only 60 engineering schools, the list given may safely be assumed to be fairly representative of the average practice of all the other engineering schools which have not been listed. Every engineering school of much present prominence or importance is included in the list.

It will be seen that with very few exceptions, the course is uniformly four years long. Only 9 out of 60 colleges, or 15%, vary from this rule, one of which has a five-year course, one (the Worcester Polytechnic Institute, a 3½-year, one a two-year course, and six a three-year course. The number of weeks of college work per year varies from 32 (in one instance, Columbia) to 40, with a single erratic exception (the Michigan Mining School), which requires 45 weeks per year, and evidently expects its students to buckle down to work, as it has more weeks of work in its three-year course than Columbia has in four years. Table XXI. shows the distribution of the colleges in respect to length of year and course, from which it is at once clear that the typical American engineering school has a four years' course of about 38 weeks per year, or 152 weeks in all. Just two-thirds of the colleges (40 out of 60) vary not more than two weeks from this average.

Many of these variations are more apparent than real, as will be seen by following down the column of "Vacation work" required in Table XX. Several of the schools which nominally have short years require a good deal of vacation work.

So far as can be judged from the face of the returns, i. e., from average practice, a shorter than four years' course is a mistake, unless the requirements for entering the three-year colleges are considerably higher than for the four-year schools. Otherwise it necessarily means that a school gives a less thorough course than average experience demands. In contemplating these long lists of studies which are now pursued in our best engineering schools, and all of which seem to be essential to a modern engineer's education, the query cannot but arise, how can so much be done, and well done, even in four years? And this question is evidently a troublesome one to the schools themselves. In the Massachusetts Institute of Technology they have sub-

Table XXI.—Summary of Number of Years in Course, and Number of Weeks in Year of 60 Engineering Schools:

Years in course.	Weeks per Year: 32	33	34	35	36	37	38	39	40	45	Total
2	..	1	..	..	..	..	..	..	..	..	1
3	..	1	..	..	1	..	2	1	..	1	6
3½	..	..	..	..	..	..	1	..	..	..	1
4	1	4	2	4	9	9	10	2	10	..	51
5	..	..	..	..	..	..	..	..	..	1	1
Total	1	6	2	4	10	9	13	3	11	1	60

Total Number of Weeks in Course.

Weeks.	No. Eng. Schs.	Weeks.	No. Eng. Schs.	Weeks.	No. Eng. Schs.
96 (2 yr.)	1	133 (4 yr.)	1	146 (4 yr.)	1
99 (3 yr.)	1	134 "	1	148 "	8
108 "	1	135 (3 yr.)	1	152 "	10
114 "	2	136 (4 yr.)	1	156 "	2
117 "	1	140 "	4	160 "	10
128 (4 yr.)	1	142 "	1	200 (5 yr.)	1
132 "	3	144 "	9		
		Total			60

* This college (University of Virginia) has six days per week.

Note.—The total number of weeks per year is not always precisely uniform, so that the first part of this table does not check precisely with the second part.

divided the work of the fourth year in the course of civil engineering into three lines, and the students must choose one of these only. These lines are: (1) railway, (2) hydraulic and sanitary, and (3) geodetic engineering, only one of which can be pursued by any one student if he limits his attendance to four years. By taking another year he could cover the entire field, as of course a large part of the work in the fourth year is common to all these lines. The mechanical and mining courses are similarly sub-divided. Among the schools having a shorter than four years' course the Thayer School of Civil Engineering of Dartmouth College is really a post-graduate school with a two-years' course, and the quantity of work required for graduation is somewhat in advance, in most directions, of the best four-year schools. We judge that an amount of study is required fairly equivalent to a five years' course at most of our engineering schools. The Sheffield Scientific School of Yale College, gives a three years' course with little if any more than the ordinary requirements for entrance, as shown in our last article, and with very little shop, laboratory or field practice. The mathematical work is of an advanced character, fully up to that required at most of the good four-year colleges, we judge, but the course as a whole is necessarily somewhat skimped by its shortness, as will appear in our next issue, and in that respect hardly worthy of so great a university, which should set the example of thorough professional training rather than lag behind it. We shall expect ere long to see the course lengthened to four years or the requirements for admission increased

correspondingly. At present the example of the university rather stands in the way of thoroughness, and it doubtless attracts some students merely because its course is shorter and requirements no greater. It may be an object for weak universities to do this, but certainly it is not for Yale.

The other three-year colleges are the University of Virginia, which compensates for the shortness of its course in some measure by having a six-day instead of a five-day week; Tuft's College, which does not seem to have gained much in attendance upon its short course; the University of Missouri School of Mines; Michigan Mining School, which has severe requirements for admission in mathematics and a rigidly technical course of study; University of resident study is completed. It is under consideration whether it may not be best to grant a degree after four years' study if desired, to correspond better with the practice of other engineering schools, but this course has not yet been adopted. This school maintains all the three engineering courses, and for several years has had a straight five-years' course of study. Perhaps this is one reason why the number of students at this excellent college is not larger, but if any change is made it might be wiser to cut off the first year, and raise the requirements for admission, rather than the last year.

The tendency in all lines of professional work is to lengthen the period of school preparation, which convinces us that four years at least, with require-

Table XX.—Length of Course, Degrees Conferred, Vacation Work Required, and Cuts Allowed Without Suspension, at 60 Engineering Schools.

(The first 52 of these schools are those for which we have published complete returns of number of graduates, and they are arranged in chronological order of first graduates. The remaining 8 schools are among those for which we have been unable to give complete statistics, from lack of reports, and they are therefore not arranged in this chronological order.)

School:	Length of course. Years.	W'ks.	Total.	Degrees conferred.	Vacation work.	Cuts allowed.
1. Rensselaer	4.40		160	C. E.	Thesis.	Variable.
2. Harvard	4.38		152	B. S. in C. E.	None.	Variable.
3. Yale	3.38		114	Ph. B.	None.	6
4. Dartmouth	4.33		132	B. S.		
5. Union Coll.	4.38		152	B. E.	None.	
6. University of Mich.	4.36		144	B. S. in C. E., etc.	None.	Variable.
7. Brooklyn Pol. Inst.	4.40		160	B. S.		
8. Penna. Mil. Ac.	4.35		140	C. E.		None. / Absence not permitted.
9. Columbia	4.32		128	C. E. (E. M.)	20 weeks.	10%
10. Wash. and Lee.	4.39		156	C. E. (E. M.)	None.	Variable.
11. Mass. Inst. Tec., C.E.	4.34		136	B. S.	Voluntary.	Variable.
11. " " " M.E.	4.33		132	B. S.	Voluntary.	Variable.
12. Lehigh	4.38		152	C. E., etc.		
13. Univ. of Va.	3.39		117*	C. E., E. M.	None.	3 per month.
14. Cornell Coll., C. E.	4.40		160	C. E., M. E., E. E.	None	Variable.
15. Tufts	3.38		114	B. Mech. Arts.		
16. Univ. of Ga.	4.36		144	B. E.	3 weeks camp.	9
17. Lafayette	4.37		148	C. E., etc.		4
18. Washington Univ.	5.40		200	C. E., etc.	6 M. E., 10 C. E., 30 E. M.	
19. Univ. of Vt	4.38		152	C. E., E. M.	4 weeks.	
20. Kansas Agric. Coll.	4.40		160	B. S.	None.	
21. Worces. Pol. Inst.	3½	3.38	133	B. S. in C. E. (or M. E.)	3½ weeks.	5
22. Alabama Pol. Inst.	4.38		152	C. E., etc.	None.	
23. Maine Agric. Coll.	4.36		144	B. C. E., B. M. E.	None.	10
24. Iowa Agric. Coll.	4.33		132	B. C. E., etc.	None.	Variable.
25. Univ. of Penna.	4.40		160	B. S.	4 weeks (C. E.)	None.
26. Stevens Inst. Tech.	4.40		160	M. E.		
27. Univ. of Wis.	4.37		148	B. C. E., etc.	None.	Variable.
28. Dartmouth, Thayer	2.33		66	C. E.	16 weeks.	Don't cut.
29. Swarthmore	4.37		148	B. S.	None.	None.
30. Cornell Coll., M. E.	4.40		160	M. E.	None.	Variable.
31. Univ. of Missouri	3.36		108	B. S. in C. E., etc.		
32. Univ. of Cal.	4.36-7		146	B. S.	None.	Variable.
33. Univ. of Kansas	4.33		132	B. C. E.	None.	Variable
34. Univ. of Minn.	4.37		148	B. C. E., etc.	None.	Variable.
35. Rutgers	4.36		144	B. S.	None.	None.
36. Univ. of Iowa	4.38		152	C. E. (now B. S.)	None.	5
37. Cornell Coll., Ia.	4.36		144	B. C. E.	None.	12
38. Univ. of Illinois	4.36		144	C. E., etc.	None.	Variable
39. Univ. of Cincinnati.	4.34		136	C. E.		
40. Princeton	4.35		140	C. E.		
41. Texas Agric. Coll.	4.39		156	B. C. E. (or M. E.)	None.	
42. Univ. of Nebraska.	4.35½		142	B. C. E.	None.	
43. Colo. Sch. of M.	4.38		152	C. E., etc.	Thesis.	Variable.
44. W. Univ. of Pa.	4.37		148	Ph. B.		
45. Pa. State Coll.	4.38		152	B. S. in C. E., etc.		
46. Purdue Univ.	4.38		152	B. C. E., etc.	None.	3 per subject.
47. Rose Pol. Inst	4.37		148	B. S.	None.	5
48. Univ. of Texas	4.35		140	B. S. in C. E.	None.	Variable.
49. Mich. Min. School.	3.45		135	E. M.	None.	Variable.
50. Mich. Agric. Coll.	4.36		144	B. S. in M. E.		
51. Ga. School of Tech.	4.36		144	B. S. in M. E.		2 days.
52. Montana Sch. of M.	4.40		160	E. M.	4 (for E. M.)	2 days.
Univ. of N. C.	4.37		148	B. E.		
St. John's, Md	4.40		160	M. E.		
Univ. City of N. Y.	3.33		99	B. S.		
Vanderbilt	4.36		144	B. E.		
Delaware	4.37		148	B. S.		
Ohio State Univ.	4.35		140	C. E.		
Univ. of Alabama	4.40		160	B. C. E., B. M. E.		
State College, Ky.	4.38		152	C. E., etc.		

* The University of Virginia week is 6 days long.

NOTES.—The Mass. Inst. Tech. requires 12 weeks vacation work for its mining course, and 4 weeks in one option for the other courses.

The records of vacation work required and (especially) number of cuts allowed without suspension are necessarily somewhat indeterminate, and hence liable to mislead if taken literally.

The form of degree is in many cases given for the "civil" course only, with "etc." after it, which means that the degrees for the mechanical, mining and other engineering courses are similar in form. The record of degrees conferred is for undergraduate degrees only, at the end of course stated in the table. All the colleges confer also post graduate degrees of C. E. or others of more dignity after 3 months to a year or more of further study or experience. On the other hand all the colleges listed, without exception so far as we recall (as well as 200 or more colleges not classed as engineering schools) have general courses in science leading to the degree of B. S. or its equivalent. These are not listed at all, not being in the nature of an engineering degree. Where B. S. or Ph. B. appear in the table it means that that is the only degree given to graduates in engineering.

of the City of New York, which has the shortest course of any engineering school in the country, aggregating only 99 weeks.

Turning now to the schools with unusually long courses, the University of Pennsylvania has the work of all its engineering courses laid out for a five-years' course, but confers bachelor degrees in engineering at the end of four years, which largely reduces the number of students taking the fifth year work. The same is true of a number of other colleges, and nearly all of them have post-graduate courses.

The Polytechnic School of Washington University, St. Louis, has the honor of being the only school which, with the same standard of requirements for admission as the best four-year school, makes all its engineering courses five years, and grants no degrees or certificates of any kind until the period ments presupposing acquaintance with algebra, geometry, trigonometry, elementary physics, history of the United States and England and one or two modern languages will be the rule hereafter, to which every school must come which aspires to rank high. A few years ago all the best medical schools required but two courses of lectures, of some six months each. Now all the leading schools require three years of eight or nine months, and the University of Michigan requires four years of nine months each. The standard of requirements for admission to the bar is also being raised everywhere. But an equally significant indication of the need for better preparation for professional life is the fact that young men everywhere are choosing to exceed the minimum requirements, to study in more than one school, to go abroad if need be, in order to lay a broad and strong foundation for future growth and for professional practice. The recent wonderful developments of science in all directions, and the endless application of science to domestic and commercial life, demand attention from all educated men, and can no longer be ignored in any kind of professional work. More especially must the young engineer, who expects to make his life work the application of scientific principles to the requirements of society, become thoroughly familiar with all those fundamental sciences by the aid of which the materials and forces of nature are brought into the service of man, and this seems to be generally realized. It seems only to be a question of time, therefore, when the schools of engineering must either lengthen the course of study beyond four years or still further specialize its courses. This latter alternative seems now to be the most probable solution. Already electrical engineering has become divorced, in most of the schools, from the wider field of mechanical engineering of which it is really a part, and the precedent now set by the Massachusetts Institute of Technology of sub-dividing the work of their civil engineering courses into narrow lines, has already been followed by the University of Wisconsin, at least, and we think by some others.

If a young man could know in advance what line of work he would follow, this specialization of the courses would certainly be the proper thing to do, but this he cannot know. In fact, even the wider and more radical lines of division between the courses of civil, mechanical, and mining engineering are very often crossed in practice, as we shall see, so that the mechanical and mining student follow civil engineering pursuits, and vice versa. Much more, therefore would the student who has prepared himself for railway engineering practice, for instance, be liable to follow some of the other lines along which his studies very poorly fitted him, as bridge, sanitary, hydraulic or geodetic engineering. On the other hand if a man is to follow bridge engineering, for which he can well fit himself in a four years' course, it seems a hardship to force him to take five years and study many subjects for which he will have no special use. Between these two alternatives the better schools are now wavering, and it cannot yet be predicted what the outcome will be. The wisest course would seem to be to limit the work of the schools to teaching a working knowledge of the fundamental principles underlying a wide field of practice, using practical methods and problems only as illustrative examples of such principles.

Engineering practice, prices of materials and of labor, and the like, change so rapidly that it seems useless to teach such matters to students. However important they may be to an engineer in practice, the student has no use for them, and when he does come to need them, both prices and practice have changed so much that his college notes are worse than useless. Furthermore, these matters are learned of necessity in actual practice, whereas new principles are then learned only by going out of one's way, returning to the text books, and brushing up one's early acquirements in a way that is usually so distasteful to a busy practical man as to be prohibitive. But worse than this, an ignorance of principles is such an ignorance as includes itself. That is, a man ignorant of a principle is not usually aware of his ignorance, or, what is the same thing, he is unaware of the existence of the principle. This is the most dangerous kind of ignorance. So long as a man knows the limitations of his own knowledge, he is a safe man, provided he is honest. But an honest ignorant man who knows not his shortcomings, is a dangerous man to trust in engineering construction. The engineering school is called upon therefore to teach all such principles as serve as a basis of engineering practice, but it is not required to teach practice any farther than necessary to give zest and reality to the work and an intelligent understanding of the uses to be made of such principles.

In all the engineering schools, a careful revision of the work from time to time, which naturally grows in all its parts, like a plant or tree, with a liberal pruning out of some of these descriptive methods and practical details, being careful always to hold fast to a thorough mastery of (and not mere having acquaintance with) the great underlying principles, would probably enable them to maintain the requisite breadth of course without increasing the time required beyond four years. This would seem

preferable to either narrowing the work for each student to a specialty, or to increasing the length of the course to five years. We shall see in a following issue as well as we can how the time is now divided.

THE ENGINEERING COURSES OF SHEFFIELD SCIENTIFIC SCHOOL; YALE.

Sir: In your issue of Sept. 1, occurs a misstatement which has before found place in your columns and was then promptly corrected by me and acknowledged as an error by you. In spite of this the same misstatement now reappears, and I therefore write to again correct it.

If you will refer to the catalogue of Yale University, a copy of which was mailed to you in response to your request for information to be used in the preparation of your articles upon the "Engineering Schools of the United States," you will find it very clearly stated, under the head of the "Sheffield Scientific School," that courses of instruction occupying three years are arranged to suit the requirements of various classes of students. The first year's work is the same for all; for the last two years the instruction is chiefly arranged in special courses. Among these special courses is one in civil engineering, also in mechanical engineering, chemistry, agriculture, biology, natural history, etc.

It is also clearly stated that all students taking any one of these three year courses receive the degree of Bachelor of Philosophy, without reference to the special course they may select.

The catalogue also distinctly states that "two additional years of engineering study are required for the degree of Civil or Mechanical Engineer." This you will find under the head of "Instruction for Graduate and Special Students."

Again, under the head of "Civil Engineering," you will find it distinctly stated that "the entire course requires five years; three years of undergraduate and two of graduate instruction." This is repeated under the head of "Mechanical Engineering."

Again, under the head of "Degrees," it is stated that "the degrees of C. E. and M. E. are conferred on Bachelors of Philosophy who have taken the first degree in engineering study and who pursue a higher course under the direction of the Governing Board for at least two years."

The practice has always been in strict accord with these requirements. No student has ever obtained the degree of C. E. or M. E. except after taking the Ph. B. degree in engineering study and at least two years of additional work as a post-graduate, one of which is sometimes replaced, by permission, with a year of practice. There has been no exception to this practice.

Any candid mind must admit that as plainly as language can state, and practice can make it, the course in engineering in the Sheffield Scientific School is a five years' course with two post-graduate years.

The result is that the school deserves and claims the merit of being almost unique in the length of its course and the stringency of its requirements for the degree of C. E. and M. E. It does not yearly turn out large numbers of undergraduates with these degrees after a three or even four years' course. Any student who takes the degree of C. E. can apply the same day for admission as Junior Member of the Am. Soc. of C. E. Few, if any, schools have held the degree higher or made it mean more. No institution has a longer required course.

Those students taking Ph. B. in engineering study may and often do seek employment at once, preferring to supplement their three years' preparation in this way. But such students do not take the degree nor the required course, and can only be spoken of as "students in engineering" to distinguish them from those selecting chemistry or biology. They are not "graduates in engineering.

These facts are well known to all interested. They are patent to any one who will consult the catalogue with the slightest care. They have been carefully stated to you personally and have appeared in your columns. You cannot therefore be supposed to be unfamiliar with them. Yet in your issue of Sept. 1, you say: "Let us take the requirements for admission to the several courses at Yale, where the requirements for the engineering courses ought to be especially thorough, as the course is only three years long; four years being the all but universal rule of the better class of engineering schools."

It is not possible to convey a more erroneous idea. The course is actually five years or one year longer than the "all but universal rule" and is doubly guarded by a preliminary degree.

Again, you say: "When we further remember that only three years of study are added to this amount of preparation, it is obvious that the respective courses are framed on the assumption that it takes much less study to learn all one needs to know in the engineering professions than in what we may call the classicals."

A simple reference to the catalogue would make it "obvious" just the other way. The course is a year longer than the "classical" and there is but one longer course in the entire university—that of Ph. D.

Again, at the head of your table you say: "Yale and several others have a three years' course, but most of the colleges agree in having a four years' course." Yet Yale is the only one whose course is five years.

You repeat this misstatement not only several times in various connections, with more or less injurious comment, in the issue of Sept. 1, but also in other issues. You do this in spite of the specific language of the catalogue, in the face of our uniform and unvarying practice and in defiance of the direct contradiction already published in your own columns. You must have some reason for thus insisting upon what would otherwise seem to be a deliberate misstatement. Will you be kind enough to state what it is? Yours truly,

A. J. Du Bois.

New Haven, Conn., Sept. 3, 1892.

Instead of the Sheffield Scientific School being "the only one (college) whose course is five years," or having any warrant to "deserve and claim the merit of being almost unique in the length of its course and the stringency of its requirements," every college of engineering in the United States, without a single exception we now recall, requires a year or more of post-graduate study, and at least five years in all, before it grants its highest degree in engineering. If there be any exceptions they must be few, unimportant and temporary. At everyone of these colleges, as also at Yale, a few scattering students take this post-graduate course. At every one of them, as also at Yale, the vast majority of students content themselves with taking the ordinary graduate degree, and neglect the post-graduate course. Thus Yale is differentiated from the other engineering schools in no respect as to the total length of its course for a post-graduate degree, but is differentiated from them in granting the ordinary undergraduate degree, in that it grants it after one year less study, with no greater requirements for admission. The particular form of degree makes no difference. Whether the "graduate" degree after a five years' course be "C. E.," "M. C. E.," "D. E. C.," or "M. S." it is equally a lie if taken literally; and if Prof. Du Bois is claiming only that his college is "almost unique" in the particular form of its degree for undergraduates (i. e., in withholding the particular degree "C. E." until after more than four years' study) he is equally mistaken. Two-thirds of the colleges do the same. Some will not grant the degree of C. E. on any terms.

It is obvious that in a general inquiry into "The Engineering Schools of the United States," only the ordinary undergraduate course, leading to the ordinary or first graduate degree can be considered. Post-graduate study of any kind, in or out of college, is an exceptional and personal thing, not affecting an inquiry into the ordinary course of instruction preparatory to the practice of engineering. This we have stated over and over again. If Prof. Du Bois considered it unfair as to his college, why did he not write and correct it when we credited his college with several times as many "graduates in engineering" as it was entitled to on his basis?

Not only "any student who takes the degree of C. E." after a five years' course at Yale, but any student who takes the degree of Ph. B. or B. S. or C. E. or D. E., or any other degree, after a course of one, two, three, four or any other number of years at Yale or any other college "of recognized standing," can apply "the same day for admission as Junior member of the Am. Soc. C. E." and be constitutionally admitted. If Prof. Du Bois had in mind the requirements of the old constitution of that society he is equally mistaken. No college course, however long, followed by any degree, however exalted, could then qualify for admission even as a Junior to that society, without a year of "actual practice" following upon his graduation. Thus even in so simple a matter as this Prof. Du Bois is utterly mistaken in his statements, of fact, and claims for his college advantages which do not and never did exist.

We may add further that out of his own mouth he is condemned when he declares that his graduate Ph. B., "are not graduates in engineering;" for immediately above that statement he declares that his full course in engineering is "five years, with two post-graduate years." What but "graduates in engineering" are these who enter upon these "post-graduate" two years after three years in the Ph. B. course in "civil engineering, also in mechanical engineering?"

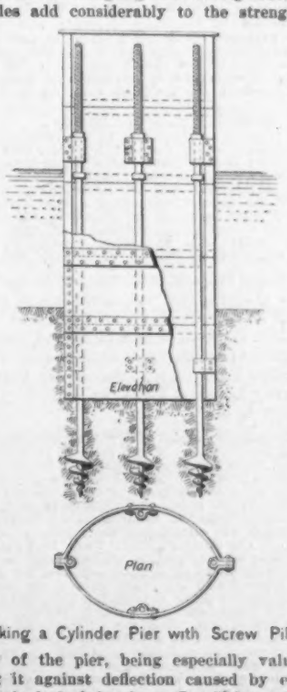
We publish the above letter in justice to ourselves rather than to the writer, as both its form and its substance would have justified us in refusing it publication. Our readers may judge for themselves whether its animus and implied charge, that we have been consciously or willingly unfair to Yale, or unfair at all has any warrant in anything which has appeared in these columns. It is impossible to carry through such an investigation as that which we are making without making prominent some facts which some colleges would rather not have made prominent, and without some minor errors at least, both of omission and commission; but so far we believe that we have succeeded in avoiding all serious errors, as we certainly have avoided all conscious bias for or against any college. We have hoped that this fact was evident.—Ed.)

SINKING A CYLINDER PIER WITH SCREW PILES.

We illustrate herewith an interesting plan for sinking iron cylinder piers, involving the use of screw piles, which has been recently patented by Mr. O. Haerem, formerly with the King Bridge Co. The scheme is to sink the screw piles first by the methods ordinarily used, then to build the iron cylinder around them, and instead of sinking it through the soft material by piling on a load, as is ordinarily practiced, to force it down to its place by screwing down nuts turning on threads cut on the upper ends of the piles.

It is claimed for this system that the screw piles act as guides to the cylinder and enable it to be kept vertical during sinking. Where a pier is sunk by loading, as soon as it begins to tip from the vertical the load upon it tends constantly to increase its inclination; with this system, however, as soon as any tip occurs the pressure on one side can be relieved and that on the other increased and the deflection may thus be corrected. A further advantage is that in case of sudden high water occurring before the pier has been sunk far, the cylinder will be held in place by the piles, and is better able to withstand the current than when it has only the soft material near the surface to hold it in place.

Besides the advantages gained during erection the screw piles add considerably to the strength and



Sinking a Cylinder Pier with Screw Piles.

stability of the pier, being especially valuable in securing it against deflection caused by excessive scour of the bed of the river. It will be noticed that the pier illustrated is parabolic in section, being intended for use in swift currents. The system is, however, equally well adapted to the sinking of piers of circular or elliptic section.

So far as we know, this system has not yet been applied in practice. The principal difficulty attending its use would apparently be in driving the screw piles, as in many river bottoms drift-wood or boulders might prevent sinking them to the proper depth and in the correct positions. Screw piles have, we believe, been most frequently and successfully used for lighthouse foundations, where the sand furnishes a

material easily penetrated and free from obstructions likely to stop the sinking of a pile. The driving of the piles accurately in position and the adjustment of the cylinder over them after driving might also be matters of some difficulty. Nevertheless it ought not to be impossible to devise methods for successfully overcoming these obstacles; and in certain soils and situations the scheme seems to have merits worth the attention of engineers and contractors.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Damages for Changing Location of Railway Crossing.

Where a railway company, in making excavations, deprived parties of the use of their acquired right of way across the company's tracks for 250 ft., but another suitable way, about 20 ft. distant, was provided for the use of the parties as a substitute for the old one, and after the lapse of about two weeks was adopted and used by them, and where it appears that the parties did not sustain any actual damage as a necessary result of this modification in the location of the way, only nominal damages would be allowed. That the parties refused for a short time to travel on the substituted way, under the impression that in doing so they would recognize a right in the railway company to make the change, and thereby surrender their rights in the old location, would not make any difference. The law makes it incumbent upon a person, for whose injury another is responsible, to use all ordinary care and to take all reasonable measures available to avoid the loss and render the damage as light as practicable, and it will not permit him to recover any damages which might have been prevented by the exercise of such care and diligence. (Fitzpatrick v. B. & M. Ry. Co., Supr. Jud. Ct. Me., 24 At. Rep., 432.)

Damages for Land Taken by Railway.

In an action to recover damages for appropriation of a right of way without license through a farm, the jury will consider the value of the land taken and the damage, if any, to the tract of which it forms part, and deduct the benefits peculiar to such tract, arising from the running of the road through it. (McReynolds v. K. C. & S. R. Co. Supr. Ct. Mo., 19 S. W. Rep., 824).

Vigilance Required When Warning Expected.

Where the danger to laborers engaged in loading cars in a gravel pit is greatly increased at times by the caving off of an embankment by other laborers, and the foreman at such times had always given warning of the danger, the laborers are entitled to expect such warning, and are not required to keep so constant a watch as they would otherwise be required to do. (Anderson v. Ogden Un. R. & Depot Co. Supr. Ct. Utah, 30 Pac. Rep., 305.)

Should Consider all the Calls.*

On a question of boundary between two surveys where the evidence as to the location of the calls in the field notes is conflicting, it is not proper to confine the consideration to one connection called for by the field notes, in disregard of evidence of other calls. (King v. Mansfield, Supr. Ct. of Tex. 19 S. W. Rep. 858.)

Reversing Calls* of Surveys.

It is not error in not ascertaining the true locality of the back line of a survey fronting, with established corners, on a river to reverse the calls of the survey, if it is found that thereby the discrepancy in the area of the survey is lessened, and the bank line falls along the line of the alleged conflicting survey, which is, moreover, of prior date; the recognized rule being that the beginning corner in the certificate of survey is of no higher dignity than any other corner. (Miles v. Sherwood, Supr. Ct. of Tex. 19 S. W. Rep. 853.)

* We are not familiar with the use of the word "call" as a synonym for "the succession of courses of a survey as recorded," which appears to be the sense in which the word is used in both of the above decisions, both of which come from Texas. If any of our readers know of this use of the word and can accurately define its limits, we shall be pleased to have them do so.

Awards for One Railway Crossing Another.

In making an award as to the manner in which one railway shall cross the right of way of another, under a statute which provides: "And if the two corporations cannot agree upon the amount of compensation to be made therefor, or the points and manner of such crossings and connections, the same shall be ascertained and determined by commissioners appointed by the court, . . ." the Commissioners have the power to order all details of construction which would be ordinarily provided for in an agreement between the parties for such purpose; and an order that stone masonry piers be substituted after a year for temporary piers supporting the bridge crossing is valid. Such an award stands as a contract between the parties, and can be enforced in like manner as a voluntary agreement, and compensation awarded and paid in money on the basis of compliance with the terms of such award as to the point and manner of making the crossing, is valid. (C. & A. R. Co., v. K. C. Y. & P. R. Co. Supr. Ct. Mo., 19 S. W. Rep., 826.)

Contract Law in England.

A contractor offered to lay certain sewers for the city of York, at a very low price. The city's officials knew that the bid was very low and that the soil was exceedingly bad, but he professed his willingness to stand by his bid and the contract was awarded to him. After completing a small part of the work he found that he was losing money and he claimed pay for alterations which had been ordered verbally by the engineer, and which under the contract were not to be paid for as extras unless ordered in writing. The city refused this and the court sustained them in the refusal. A specification providing that work shall be done to the satisfaction of the engineer is final. (Bottem vs. York, English Ct. of App.)

Liability for Not Fencing Railway.

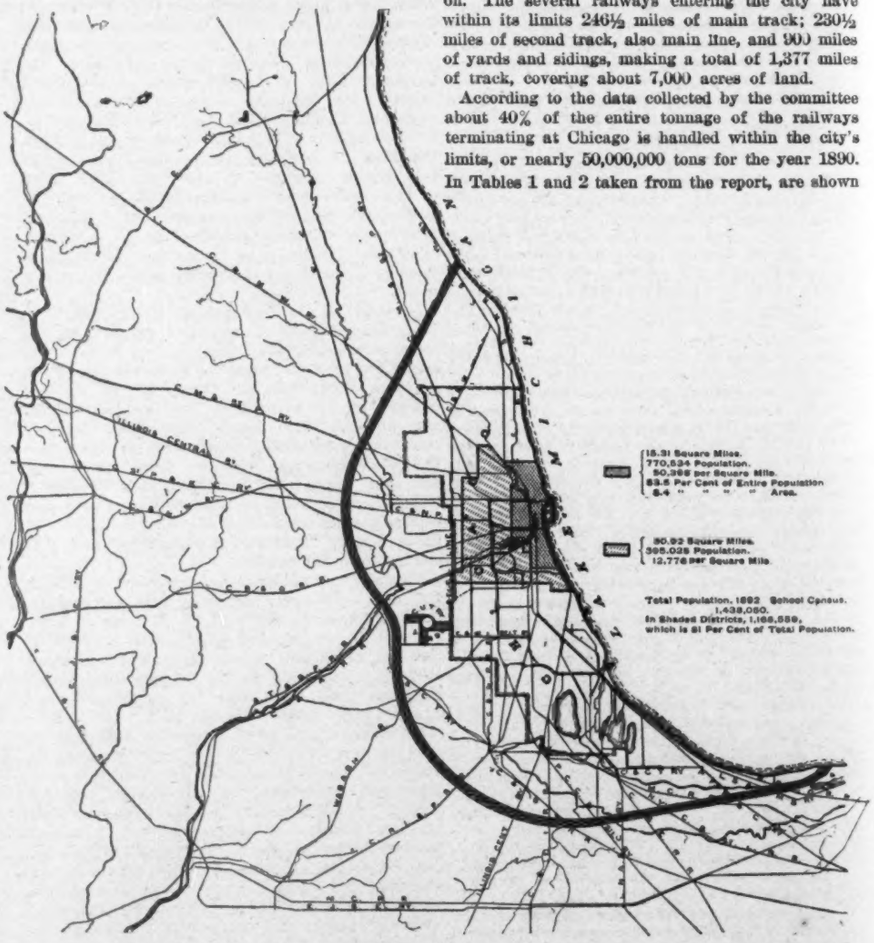
A space about 100 to 180 ft. wide to the south of a railway and between it and a river nonfordable at that point, was occupied by a station platform and mill house, the mill yard extending for 400 ft. to the east of the platform up to a creek and bridge, and being used for the storage of logs. A switch ran for 280 ft. to the east of the platform, at which end was an open space, unfenced, for the necessary convenience of the public and the business of the corporation. This open space is not a place, within the provision of the statute, where a fence "is necessary to prevent" animals "from getting on the tracks from the lands adjoining the same." And under the statute making a railway company liable for damages done by its engines or agents to animals on the railway through non-maintenance of a necessary fence to its road, the death of such animal must be the result of its being struck by the engine, and not of its jumping off the track on the engine's approach. (Hyatt v. N. Y., L. E. & W. R. Co. Supr. Ct. N. Y., 5th Dept., 19 N. Y., Sup., 461.)

Where Signals Are Not Given.

A person crossing a railroad has a right to assume that the statutory signals will be given, and so act. But where he could not have seen the train in time to have avoided the catastrophe, if he had looked, looking before he reached the track would have been fruitless; and if the signals were not given, listening would have been fruitless likewise. In such case he could not be held to have been guilty of negligence directly contributing to his injury by failing to look and listen for an approaching train. (Crumpley v. H. & St. J. R. Co. Supr. Ct. Mo., 19 S. W. Rep., 820.)

THE CHICAGO UNION TRANSFER RAILWAY.

In our issue of Feb. 8, 1890, we gave a map and description of the proposed transfer yards of the Chicago Union Transfer Co., together with some general details of the enterprise, which has for its object the removal of the enormous transfer business from the streets of Chicago and its concentration on a tract of land lying west of the city limits. In Chicago, as in other large railway centers, the business of the railways has outgrown the systems of transfer which were designed when traffic was light, and, more especially, when the ratio of through freight to local freight was vastly smaller than it is now. Many of the railway terminal yards are now located within or near the city limits and in many cases are so crowded that it is impossible to provide for the ever increasing business. This has brought about a demand for new yards or less expensive land and where the public and the necessary transfer business will less embarrass each other.


15.31 Square Miles.
770,534 Population.
50,366 per Square Mile.
83.5 Per Cent of Entire Population
8.4 " " " Area.
80.92 Square Miles.
306,025 Population.
12,776 per Square Mile.
Total Population, 1892 School Census. 1,439,060.
In Shaded Districts, 1,166,559,
which is 81 Per Cent of Total Population.

MAP SHOWING PROPOSED BELT LINE OF THE CHICAGO UNION TRANSFER RAILWAY; W. S. Jones, Chief Engineer.

To provide the additional facilities required the Chicago Union Transfer Co. was organized as described in the article before referred to. As yet, however, little has been done toward carrying out the plan as proposed owing to the difficulty in getting a sufficient number of railway companies to approve it.

In brief, the scheme included the construction of a belt line railway of two or more tracks partly encircling the city and crossing all the railway lines centering there, and the building of large transfer yards as described in our former article. Recently a committee, with W. S. Jones as Chief Engineer, was appointed to submit plans for the proposed belt line, and from its report, issued last week, we abstract the following details and map of the line.

Before taking up the construction of the belt line proper it is interesting to note some of the conditions which demand its construction. By referring to the map it will be seen that more than 50% of the entire population of the city of Chicago is included in the area covered by the heavy shading, and in this district all the railways have their passenger and freight terminals. Within the area covered by the lighter shading nearly all the transfer business of these railways is carried on. The several railways entering the city have within its limits 246½ miles of main track; 230½ miles of second track, also main line, and 900 miles of yards and sidings, making a total of 1,377 miles of track, covering about 7,000 acres of land.

According to the data collected by the committee about 40% of the entire tonnage of the railways terminating at Chicago is handled within the city's limits, or nearly 50,000,000 tons for the year 1890. In Tables 1 and 2 taken from the report, are shown the absolute growth and the increase per cent. in the freight traffic of these lines since 1880.

Table 1.—Showing Increase in Total Freight Operations of all Railways Terminating in Chicago, 1880 to 1890.

Date.	No. cars owned. 1 = 1,000.	Train mileage. 1 = 1,000.	Tons carried. 1 = 1,000.	Ton mileage. 1 = 1,000
1880	105	65,911	51,558	9,022,104
1885	169	87,742	69,142	13,790,060
1890	236	121,707	119,284	22,817,234

Table 2.—Showing Percentage of Increase in Freight Operations of all Railways Terminating in Chicago, 1880 to 1890.

Date.	Cars owned. P.c.	Tr. mileage. P.c.	Tons frt. carried. P.c.	Ton mile'ge. P.c.
1880 to 1885	51	33	34	43
1885 to 1890	47	50	73	65
1880 to 1890	122	99	131	137

From these figures it will be seen that the increase in freight tonnage since 1880 has been 131%. In 1890 the freight tonnage of these roads was 119,284,935 tons or 17.2% of the entire tonnage of all the railways in the United States.

In Table 3 are shown the receipts and shipments at Chicago of a number of the principal commodities during the year 1891:

Table 3.—Showing Receipts and Shipments at Chicago of Various Commodities in Car Loads, During 1891, as Compiled from Board of Trade Report.

	Received.	Shipped.	Total car loads.
Grain	302,000	128,000	
Live stock	305,000	100,000	835,000
Lumber and coal			500,000
Dressed meats			180,000
Seeds			105,000
Flour			46,000
Total			1,664,000
About an equal number of empties handled, makes total cars			3,328,000

In addition the report shows that during the year 1891 the C. & W. I. Belt transferred 580,871 cars, the Chicago Railway Transfer Association 582,487 cars, and the St. Charles Air Line 180,837 cars. Of the direct transfers the C. & Now'n. Ry. made 404,551, the C., B. & Q. R. R. 150,606, which aggregates 1,890,352 transfers. From other data and estimates, the direct transfers made by other roads are estimated to reach about 2,500,000 cars, making the total for 1891 nearly 4,400,000 cars handled.

Commenting on these figures the report says:

The necessity for taking immediate steps in some definite direction looking to the construction of an adequate transfer system, may be readily realized by a consideration of the growth of the railroad systems which terminate in Chicago. Another reason for taking some steps looking to the relief of the railway business here, is the constant, and at present unavoidable delay in handling cars, coupled with the unnecessary delays on team and industrial tracks. The delays from this last cause will aggregate 1,500,000 car-days per annum, while delays arising from existing yard locations, inadequate and transfer facilities, will reach, at a low estimate, 5,000,000 car-days per annum. The average earnings per car-day in the United States, as deduced from the reports of 1890, is $1.90; the average time consumed in loading, shipping, and unloading a car is 4 4-10 days for each load, which would make the earning capacity of a car on a long haul, or during the busy season, over $8 per day. It is not claimed, however, that all this could be saved, but we leave it to the operating departments of the various railroads to make their own estimates from the above data.

We believe that the construction and use of this or some other similar system of transfers would not only have the effect of facilitating transfers and reducing delays, but it would also result in relieving from active service from 25 to 50% of the switching engines and crews now in use, thereby effecting a large saving to the roads annually. One manager says, that if a general system of transfers, such as herein contemplated, were adopted, more than 25% of the switching engines now in use on his road would be relieved, thereby effecting a saving of $100,000 per annum to his company, and that with this system it would be impossible to have a blockade.

The general location of the belt line is plainly shown in the accompanying map. Its total length from lake to lake will be 63.78 miles and in this distance it will cross and connect with 23 main lines of railway entering the city. Some of the principal physical features of the line as planned, are shown in the following table:

Total length of line from C. & Nown. Ry to B. & O. R. R.	60.3 miles
Length of straight line	58.07 "
" curved line	2.23 "
Total number of degrees of curvature	354°
Maximum degree of curvature	3°
Maximum grade per mile	16 ft.
Length of longest maximum grade	1.6 miles
Miles of track on which grade is 16 ft	13.7 "
Miles of track on which grade is less than 10 ft. and more than 5 ft.	17.6 "
Miles of track on which grade is less than 5 ft. per mile	29.0 "
Maximum elevation above Lake Michigan	71 ft.
Minimum elevation above Lake Michigan	11 ft.
Total ascent on whole line	260 ft.
No. of sub-grade crossings	11
" overhead crossings	2
" grade railway crossings at points where there are existing crossings	5
No. of new grade railway crossings	8
" overhead highway crossings	3
" sub-grade highway crossings	3
" grade highway crossings	83
" river and creek crossings	7
Length of iron bridging on proposed line	1,200 ft
" iron bridging on other roads	2,100 "
" iron bridging on high ways	1,320 "
" iron bridging on other small openings	250 "
Total iron bridging	3,970 ft
No. of arch culverts	10
" iron and box culverts	60

The right of way will be generally 200 ft. wide, being less than 200 ft. only at such points as it is reasonable to suppose that industries will not be located. In no place is the right of way to be less than is required for four tracks. As it is intended to furnish only such facilities as are required at the present time, leaving the additional facilities until required by the increase in traffic, only the following tracks are planned for construction: A double track line from the Milwaukee Division of the Chicago & Northwestern Ry., to the Wisconsin Central R. R.; a four-track line from this last point to the New York, Chicago & St. Louis R. R., and a double track line from here to the Baltimore & Ohio R. R.

The width of embankment for double-track railway will be 28 ft., and for four-track railway, 56 ft. The width of excavation of double-track railway is to be 32 ft., and for four-track railway, 60 ft., with slopes in earth of 1½ to 1, and in rock of ½ to 1. All culverts to be of stone, or stone and iron, and all bridges are to be constructed of masonry abutments, and steel superstructure. All railway crossings, where possible, are to be overhead or under. Railway crossings at grade are to be interlocked. Both overhead railway and highway crossings are to be carried on steel columns, with masonry piers and steel superstructure. The track is to be laid with 80-lb. steel rails and the best pattern of rail joints, with oak ties, and gravel ballast. The total estimated cost of the line is $5,500,000.

The financial plan by which this enterprise is to be carried out as explained in our previous article, is to have each of the companies whose lines enter Chicago subscribe to the stock of the Chicago Union Transfer Co., and thus receive all the profits of the enterprise. So far only a part of the roads have approved the plan but it is hoped that the remainder will soon do so. If the united action of the companies cannot be secured some other plan will be devised to raise the money.

CEMENT JOINTS FOR CAST IRON WATER MAINS.

In our issue of May 5, 1892, a correspondent asked for information regarding the use of cement in place of lead for joints in cast iron water mains. The only instance we could cite at the time was in connection with a private supply to a factory where the pressure was light. These joints leaked, we were informed.

In our issue of June 23, 1892, Mr. R. H. M. Blake, of Guadalajara, Mexico, stated in a letter that in 1880 he found about 1,000 ft. of 6-in. main with cement joints at Central Falls, R. I. This pipe was used for fire protection and was subjected to heavy pressure.

Further information, evidently regarding this same pipe at Central Falls, was given in our issue of July 14, 1892, by W. P. Snow, Auburndale, Mass., and J. E. Andrew, Secretary Pawtucket, (R. I.) Steam & Gas Pipe Co. The latter company laid pipe with joints of tarred rope and Roman cement, in 1869 and 1870. This pipe has stood service for more than 20 years, with pressure as high as 150 lbs.

We are pleased to be able to add to the information on this subject the valuable experience of Mr. L. T. G. Evans, Engineer of the Nottingham Corporation Water-Works, England. Under date of July 4, 1892, Mr. Evans sent us a standard section of a straight socket joint for which cement is used. The section was accompanied with a table showing the dimensions for the different parts of the joint for different diameters of pipe. The section and table are given herewith. Mr. Evans writes as follows:

In your issue of June 23, just to hand, I notice a letter from one of your Mexican correspondents on cement joints in water pipes, and in response to your invitation for information, I have much pleasure in forwarding for the use of your numerous subscribers a table, showing the various sizes of turned and bored socket water pipes, suitable for cement jointing.

The spigots and sockets are carefully turned and bored by special machinery to templates, and afterward receive a coating of tallow to prevent oxidation. In laying the pipes in the trenches, this tallow is wiped off, and a coating of neat liquid cement takes its place. The pipe is then lowered into position, and driven home by a wooden mallet, with a force depend-

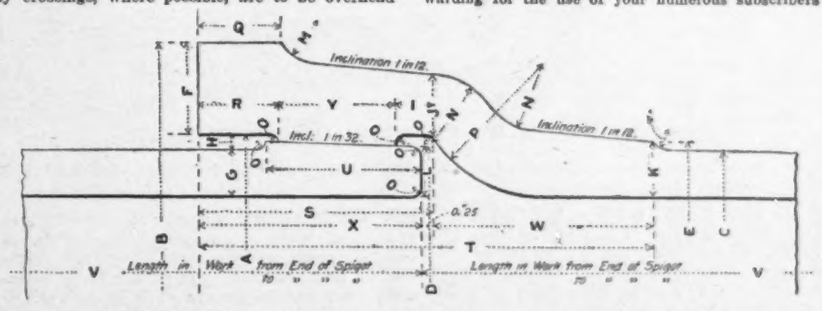


DIAGRAM SHOWING POSITION OF DIMENSIONS REFERRED TO IN TABLE.

Dimensions of Joints for Different Sizes of Cast Iron Pipe Where Cement is Used for Calking.

Diam. pipe, ins.	Diameters A	B	C	D	E	Thickness F	G	H	I	J	K	L	Radii M	N	O	P	Lengths Q	R	S	T	U	V	W	X	Y
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.		Ins.	Ins.	Ins.
2	3.2	5.575	2.7	2.875	2.875	.9375	.350	.25	.375	.625	.4375	.4375	.75	1.	.1874	1.125	.875	1.25	3.	6.25	1.625	6'3".75	3.25	2.75	1.375
2½	3.7	5.7	3.2	3.375	3.375	1.	.350	.25	.375	.625	.4375	.4375	.75	1.0625	.1875	1.125	.875	1.25	3.	6.25	1.625	9'3".75	3.25	2.75	1.375
3	4.2	6.325	3.7	3.95	4.	1.0625	.350	.25	.375	.6875	.5	.475	.75	1.126	.1875	1.25	1.	1.25	3.	6.25	1.625	9'3".75	3.25	2.75	1.375
4	5.25	7.625	4.75	4.9	5.05	1.1875	.375	.25	.375	.75	.525	.4	.75	1.125	.1875	1.25	1.125	1.25	3.375	6.75	2.	9'3".125	3.375	3.125	1.75
5	6.425	8.925	5.8	6.	6.1	1.25	.4	.3125	.375	.75	.55	.5	.75	1.1875	.1875	1.125	1.1875	1.375	3.5	7.	2.	9'3".25	3.5	3.25	1.75
6	7.475	9.975	6.85	7.	7.16	1.25	.425	.3125	.625	.75	.58	.5	.75	1.1875	.1875	1.4375	1.1876	1.375	3.75	7.375	2.25	9'3".5	3.625	3.5	1.75
7	8.525	11.15	7.9	8.	8.2	1.3125	.45	.3125	.625	.8125	.6	.5	.75	1.25	.1875	1.5	1.25	1.375	4.	7.625	2.25	9'3".5	3.875	3.5	1.75
8	9.575	12.2	8.95	9.125	9.375	1.3125	.475	.3125	.625	.8125	.6875	.5625	.75	1.3125	.1875	1.6875	1.25	1.375	4.	7.75	2.5	9'3".75	3.75	3.75	2.
9	10.75	13.5	10.125	10.25	10.375	1.375	.5625	.3125	.625	.875	.6875	.625	.75	1.75	.1875	1.75	1.25	1.375	4.	8.	2.5	12'3".75	4.	3.75	2.
10	11.75	14.5	11.75	11.25	11.45	1.375	.5625	.3125	.625	.9375	.725	.625	.75	1.3125	.1875	1.75	1.25	1.375	4.125	8.125	2.625	12'3".875	4.	3.875	2.125
12	13.82	16.825	13.2	13.375	13.5	1.5	.6	.3125	.75	.9.75	.75	.6875	.9375	1.3125	.1875	1.75	1.375	1.375	4.5	8.375	3.125	12'4".25	3.875	4.25	2.375
14	16.	19.25	15.375	15.5	15.625	1.625	.6875	.3125	.9375	1.	.8125	.75	.9375	1.3125	.1875	1.9375	1.4375	1.375	4.625	8.75	3.25	12 4".375	4.125	4.375	2.375
15	17.025	20.275	16.4	16.5	16.75	1.625	.7	.3125	.9375	1.0625	.875	.75	.9375	1.125	.1875	2.1875	1.4375	1.375	4.625	9.	3.25	12'4".375	4.375	4.375	2.375
16	18.075	21.325	17.45	17.5625	17.75	1.625	.725	.3125	.75	1.0625	.875	.78125	.9375	1.3125	.1875	2.15625	1.4375	1.5	4.625	9.	3.125	12'4".565	4.375	4.375	2.375
18	20.175	23.55	19.55	19.76	19.9	1.6875	.775	.3125	.75	1.1	.96	.82	.875	1.375	.1875	2.3125	1.5	1.5	4.625	9.	3.125	12'4".575	4.375	4.375	2.375
24	26.5	30.25	25.375	26.	26.2	1.875	.9375	.3125	.75	1.25	1.1	1.	.875	1.375	.1875	2.625	1 6875	1.625	4.75	9.25	3.125	12'4".5	4.5	4.5	2.375

ing upon the size of the pipe; during this operation the foreman should be at the point feeling the progress made by each blow of the mallet, until no further movement is discernible, and the sound is metal to metal.

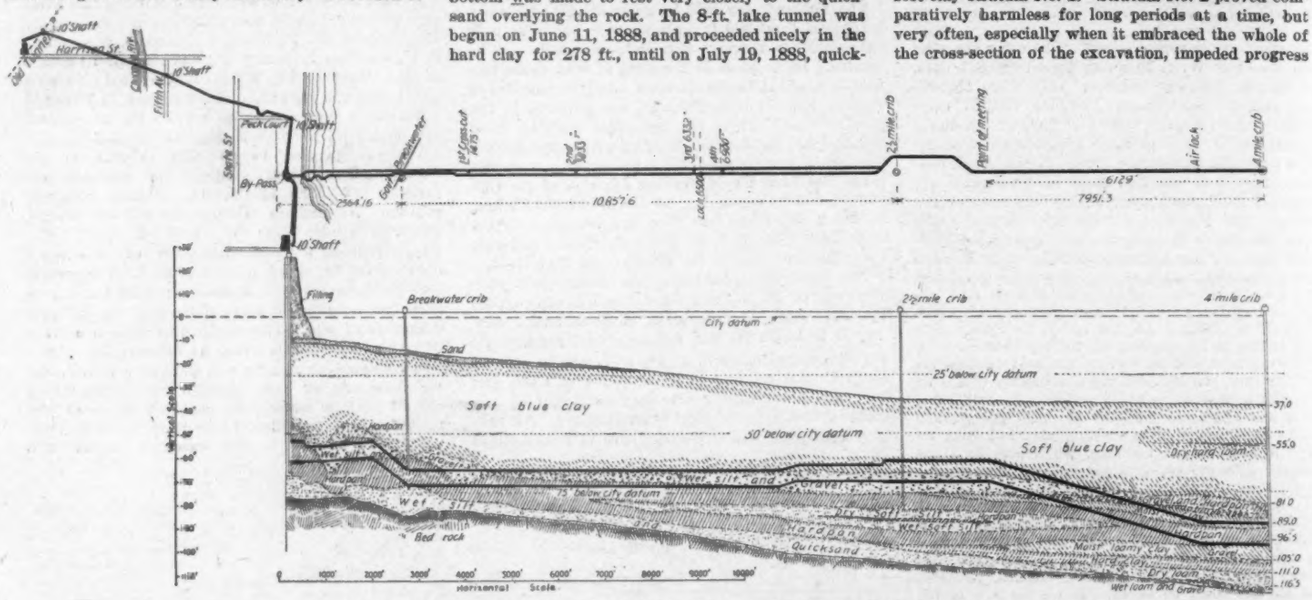
The extra cost entailed in machinery over the common lead jointing varies from $1.20, in the small diameters, to 85 cts. per ton in the larger diameters. This slight difference in first cost is exceedingly small compared with the great saving in lead, yarn, grip poles, labor, etc. The only places where they are not suitable are in colliery and mining districts, or when expansion and contraction is considerable from the varying temperature of the water, such as frequently takes place from water flowing from an open reservoir.

When old pipes with cement joints have been taken up from different causes, I have invariably found the joints sound and good, even in places where the concussion has been considerable. In conclusion, I have every confidence in recommending this system for trial, and, finally, of its ultimate acceptance.

CHICAGO'S NEW FOUR-MILE LAKE TUNNEL AND ITS APPENDAGES.

By Bernhard Feind, M. Am. Soc. C. E.

The new four-mile water tunnel for Chicago is now nearing completion and is expected to be put into operation in the early fall of this year. It is interesting to review briefly its history. Attention is invited to a comprehensive article on this subject by the writer which appeared in Engineering News of July 5, 1890, with an inset sheet of illustrations.



PLAN AND PROFILE OF FOUR-MILE TUNNEL, CHICAGO WATER SUPPLY.

The accompanying plan gives the location of the lake tunnel and of its land appendages and the profile is that of the lake tuunel proper.

The location of the tunnel was chosen and preliminary borings were made on the land and under the lake during the summer of 1887. The contract was let to Andrew Onderdonk, of New York, on Nov. 18, 1887, and he has constructed the entire system with the exception of three 10-ft. land shafts and a few hundred feet of 6-ft. land tunnel which were built by the city.

Four-Mile Lake Tunnel Proper.

Ground was broken for the shore shaft of the lake tunnel in December, 1887. It was first located at the foot of Peck Court and the intention was to run the lake tunnel due east from this point. Quicksand was struck Jan. 15, 1888, and after a protracted struggle the idea of using this shaft as a shore shaft for the lake tunnel was relinquished, and a new shore shaft at the foot of Park Row, about 1,200 ft. to the south of the old one, was begun on May 3, 1888. It may here be mentioned that almost from the first borings over the entire system were carried on in advance of construction, under the direction of the engineer in charge, and that these borings proved the preliminary borings above mentioned to be not only unreliable but entirely misleading. While the preliminary borings showed only clay, hardening with increasing depth, the construction borings, if they may be so termed, showed the following general stratification from the surface down:

(1) Soft swelling clay. (2) Water-bearing stratum consisting of silt, sand and gravel. (3) Hard clay, also called boulder-clay from the frequent occurrence of glacial boulders. (4) Water-bearing stratum consisting of silt, sand, gravel and quicksand, which latter was really nothing else than water under a head and heavily charged with fine silt. (5) Limestone rock fragments. (6) Limestone bed rock.

The strata were undulating, varying in thickness and often split in two. The only stratum favorable for tunnelling was the hard clay stratum. On the whole the stratification lines conform to the lake bottom, so that a grade rising from lake to shore became necessary in order to stay as long as possible in the hard clay stratum. This was the reverse of what the original plans contemplated, which placed the grade at the shore shaft at —80 and at the lake terminal or intake shaft 4 ft. higher, or at—76. As built, the grade at the shore shaft it —68 and at the intake shaft—97.

The new shore shaft at Park Row was sunk with the aid of very heavy top-loads necessitated by the friction to be overcome in passing through the thick upper layer of swelling clay, and its inverted bottom was made to rest very closely to the quicksand overlying the rock. The 8-ft. lake tunnel was begun on June 11, 1888, and proceeded nicely in the hard clay for 278 ft., until on July 19, 1888, quicksand was struck at the bottom and swelling clay at the top. Work was suspended for a while. A hydraulic shield was procured and put into operation on Sept. 18, 1888. It proved to be structurally weak and the diameter of its pressure cylinders proved to be too small, a fact which necessitated the use of enormous pressure units, as high as 12,000 lbs. per sq. inch, causing innumerable breaks and delays for repairs and improvements. The swelling clay thus gathering headway finally moved down in its entire thickness of 50 ft. and a deep hole formed in the lake bottom over the shield. The latter, without having made any progress to speak of, was abandoned, and the contractor asked and received permission to build two 6-ft. tunnels in lieu of one 8-ft. tunnel for a certain distance.

Two 6-ft. tunnels, it may be stated, elongated 4 ins. vertically give almost the same volume of flow as one 8-ft. tunnel elongated 2 ins. vertically, with the same slope and n=0.015 (Kutter's formula); but under the same conditions of heavy roof soil the line of pressure in the top arch is slightly more favorable for the 8-ft. tunnel than for the 6-ft. tunnel, when both tunnels are lined with brick, the 8-ft. having three rings, or a lining 13 ins. thick and the 6-ft. two rings, 9 ins. thick.

The southern 6-ft. branch was begun on Nov. 15, 1888, the northern one on Dec. 12, 1888, and fair progress was made in both headings as a rule, although they ran above the hard clay into soft or water-bearing soil belonging to stratum No. 2. In order to reach again the hard clay a crib and shaft were interpolated at the intersection of the tunnel line with the Government breakwater, about 2,000 ft. from shore. The crib (see inset, Eng. News, July 5, 1890) was set on March 27, 1889; the shaft was begun in the latter part of April, 1889. The water-bearing stratum No. 2 caused great trouble, but the shaft was finally sunk through the hard clay stratum and its invert made to rest on the water-bearing stratum No. 4. A lateral chamber was constructed in the hard clay from the shaft to the northward and from this chamber there issued four 6-ft. headings, two landward and two lakeward. The grade at this point is 13 ft. lower than that in the shore shaft. The landward headings with their steep grade made fair progress on the whole, although the over-head water-bearing stratum troubled them sometimes; they met the shore headings on Aug. 22 and 31, 1889, respectively. The two 6-ft. lakeward headings were carried on at a varying rate of progress during 1889, 1890 and 1891. They began in the hard clay stratum and necessarily ran on a horizontal grade, because a downward grade under the existing conditions of material was out of the question, and on account of the general east dip of the stratification they gradually passed into the water-bearing stratum No. 2, and afterward into the soft clay stratum No. 1. Stratum No. 2 proved comparatively harmless for long periods at a time, but very often, especially when it embraced the whole of the cross-section of the excavation, impeded progress very materially. Whenever the tunnel cross-section lay fully in the soft clay stratum No. 1, very fair progress was made.

At last the contractor decided to operate all the headings of the lake tunnel under compressed air. On Feb. 12, 1891, work was suspended in both shore headings. An air lock was placed in the southern heading at a distance of about 8,500 ft. from shore. On March 20, 1891, work was resumed in this heading with a pressure of 17 lbs. per sq. in. (above atmosphere) in the lock. At a distance of about 8,900 ft. from shore an oblique cross-cut tunnel was built which intersected the axis of the northern heading about 250 ft. in advance or east of its finished face, and work was carried on in both headings, with a pressure in the lock ranging from 17 to 22 lbs. per sq. in. (above atmosphere) at a rate of progress very satisfactory and uniform. Cross-cut tunnels were built at intervals, establishing communication between the two headings, which was necessary in case of serious accidents in either heading, and for preparing mortar not too far from the face, and very convenient for transportation purposes and for checks on the alignments.

The developments in the work of tunneling from the intermediate or 2½-mile lake shaft in the meanwhile had been such that the city authorities decided to abandon the intermediate structure entirely and to avoid approaching it with the headings from shore and from the terminal or intake shaft. Accordingly the two 6-ft. shore headings were joined into one 8-ft. heading. This junction is located about 450 ft.

landward or to the west of the 2½-mile shaft and was finished by Dec. 13, 1891. The single 8-ft. heading was deflected to the north and carried around the intermediate shaft so as not to approach it at any point nearer than about 350 ft., and afterward was deflected to the south again in order to meet the single 8-ft. heading coming from the four-mile shaft.

The contractor, anxious to try to shorten the haul of the excavated soil by dumping from the 2½-mile crib instead of from the breakwater crib, commenced the construction of a 6-ft. branch issuing at right angles from the 8-ft. main tunnel, where it is deflected to the north, intending to connect this branch with a short stub of a 6-ft. tunnel built under pressure from the 2½-mile shaft westward on the line of the shore headings. This connection was never made and the branch is not shown on the plan.

The above mentined gap of about 250 ft. in the northern heading was filled between Nov. 17, 1891, and Dec. 10, 1891, by tunneling under air pressure westward from the junction of the oblique cross-cut with the northern heading. A few feet of soil had to be left untouched, however, because the stretch of tunnel beyond, coming from the breakwater shaft, was not under air pressure. In that portion of this stretch which lies between the distances of 6,000 and 6,100 ft. from the breakwater shaft and at a distance of 400 ft. from the air-lock, with which it is connected by cross-cut No. 3 (see plan), there occurred, during October, 1891, several serious irruptions of quicksand, gas, and air escaped from the eastward tunnels under pressure, and it was deemed expedient to isolate this place by closing cross-cut No. 3, and bulkheading the northern 6-ft. tunnel just east of cross-cut No. 2.

The single 8-ft. heading from the four-mile or intake shaft west or landward, was begun on Jan. 12, 1891.

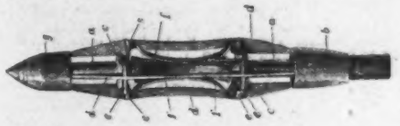
Progress was at times impeded by soft clay in the roof. This heading was closed down on June 6, 1891, and an air-lock was placed at a distance of 1,450 ft. from the shaft, and June 20, 1891, tunneling was resumed under a pressure from 10 to 15 lbs. (above atmosphere) in the lock and continued at a gratifying and uniform rate of progress until the shore heading was met. On June 27, 1892, at 4:30 a. m., the connection between shore shaft and four-mile intake shaft was completed. The compressed air was then blown off and the locks were thrown open. Then an irruption of gas and quicksand occurred in a defective portion of the southern 6-ft. tunnel close to the lock. This portion had not been built under pressure but was put under pressure after it had been built, as the air-lock had to be set back from the existing face quite a distance. The locks were closed and the pressure was turned on again, and the defective stretch of tunnel was cleared from the influx masses and reconstructed.

The contractor is now busily engaged in cleaning out the whole of the lake tunnel, and is about to begin reconstructing under air pressure that portion of the northern 6-ft. tunnel in which the irruptions occurred during October, 1891, and which was isolated in consequence, as described above. It is not intended to reconstruct those portions of the tunnel in which a heavy roof pressure has merely distorted the cross-section and flattened out the circle vertically elongated to an ellipse with a horizontal major axis, without destroying or impairing the texture of the material. Careful computations made by the writer revealed the fact that it would require a distortion of 10 ins. (diminution in height and increase in width) to bring about a reduction of the flowing capacity by 2%, and that for all the delay and danger involved in an attempt to restore the correct cross-section in a 2,000-ft. stretch of double 6-ft. tunnel thus distorted, the city would only be compensated by a saving in operating expenses of $60 per annum. The largest distortion that has actually taken place in the tunnel is 8-ins. for a length of a few hundred feet of single 6-ft. tunnel.

(To be continued.)

SCRAPER FOR BOILER TUBES.

The form of scraper here illustrated is of German design, and is said to be specially adapted for the thorough cleaning of boiler tubes of locomotives and portable engines. The following description and cut are taken from the "Centralblatt der Bauverwaltung." The part A is screwed on to the rod of the instrument and is furnished with guiding rings, C, and sleeve, B. The four ribs D, which are provided with the overlapping ring segments E, are made to slide in radial grooves of the fixed rings C, the segments forming two complete scraper rings which are pressed against the inner walls of the



Scraper for Boiler Tubes.

tube by the springs F. Worn out parts may easily be replaced by removing the cap G. These scrapers are manufactured by P. Sechler, Stuttgart, Germany, to fit tubes from 1¼ to 3 15-16 ins. inside diameter. The prices range from $3 to $7.25.

THE PROTECTION OF CANAL BANKS IN FRANCE AND HOLLAND.

At the late Paris Congress on Inland Navigation, M. Peslin described the system of protection adopted in the canals of the North of France, where the traffic was heavy and the banks were exposed to wash from steam tugs towing barges.

Wood piling and fascine work were usually employed, and the simple forms of protection were described as follows: Piles about 8 ft. long and 6 ins. in diameter, spaced 2 ft. 6 ins. apart, were driven down to the water-level and cut off 6 ins. below navigation level. Behind these piles 12 in. fascines of tree branches were laid, as shown in Fig. 1. The cost was about 12 cts. per lineal foot; but unless the piles were made of oak, increasing the total cost to about 18 cts. per foot, this work decayed rapidly. In some cases planks are used instead of the fascines.

Where the traffic exceeds 500,000 tons per annum, the banks are protected by masonry walls, as shown in Fig. 2. The piles are of the same size and driven as before described, but the heads are cut off at an angle of 45° 6 ins. below the lowest water level. A cap-sill of 2½ in. is spiked to the pile head and a 9 in. by 1 in. waling is nailed to the back of the piles. Six inches of broken brick is then rammed in

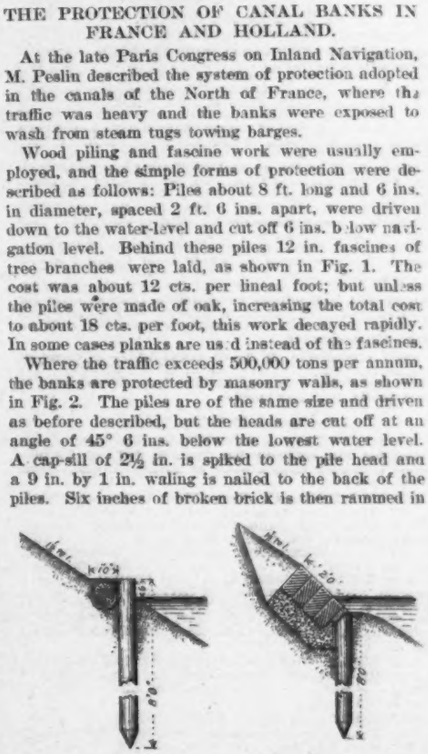


Fig. 1. Fig. 2.

Methods of Protecting Canal Banks.

behind the piles and on this are laid dry blocks of stone, or brick of the ordinary size. This work, when all done, lasts a long time and costs 60 cts. per lineal foot for four stone blocks 6 ins. deep and laid as shown in Fig. 2. For every additional course of blocks the cost is about 6½ cts. per foot of course. In some places the joints are filled with a grout made of equal parts of ground hydraulic lime, sand and riddled coal ashes. The same system of bank protection has been adopted on some of the Holland canals.

Mr. Van der Sleyden, at the same Congress, said the banks of the North Holland Canal were protected by driving piles, 11½ ft. long, at intervals of 2 ft. and connecting these by a back waling 10 in. by 2 in. Behind this waling 10 ft. sheeting was driven. Where the ground was liable to slip, the front piles were tied by rods to back piles. The surface of the bank above the piles was protected by sods, brick or stone, as the traffic demanded. The cost of this protection was from 84 cts. to $1.76 per lineal foot of bank. The advantage claimed for this system is that it can be put in place without lowering the water level in the canal, or interfering with the traffic. As the piles are driven nearly vertical the width of the canal is practically increased, as the natural slope gradually disappears.

The electrically operated railways in the United States on Oct. 1, 1891, amounted to 385 roads, with 3,916 miles. This plant included 5,470 motor cars and 2,930 trail cars, and the capital invested was $155,067,973. On June 1, 1892, there were 425 electrical roads, 5,071 miles operated, 6,477 motor cars and 2,986 trail cars, with $188,245,632 in invested capital. Since June 1, the city of Brooklyn is changing from horses to electricity; trolley lines are being constructed in Providence, R. I., and New Haven, Conn. The state of Pennsylvania now leads with 45 electric roads; Ohio has 28; New York, 33; Massachusetts, 30; Washington, 27, Illinois, 24, and Michigan, 22.

A grain train of forty 34-ft. box cars has been run from Chicago to Jersey City, on the Pennsylvania Railroad, without breaking link or changing locomotive. The distance was 804 miles; the train length, 1,602 ft.; load of grain carried, 2,640,000 lbs. The engine weighed 88,500 lbs., and the caboose 18,000 lbs. The total weight of the train was 4,030,000 lbs. The train was equipped throughout with Westinghouse brakes.

The first train between Jaffa and Jerusalem passed over the line on Aug. 30, the railway being now completed between these two points. The distance is 54 miles, and the estimated cost is $1,200,000. The concession was granted in 1888 to the Societe Anonyme Ottmane, of Paris.

The Trans-Siberian Railway, officially says the Russian Government, will be completed in six years; probably meaning in the various sections which are to connect existing water-ways. At the present time about 540 miles, at the Omsk end, and about 240 miles out from Vladivostock, at the east end, are under construction. The same report says that the most profitable of the state railways in Russia, at the present time, is the Trans-Caucasian line, between Batoum and Baku. The estimated receipts are 16,500,000 roubles, with expenses of 6,000,000 roubles.

The British Indian coal product has increased from 1,389,000 tons, in 1886, to 2,168,000 tons in 1890, according to the last "Annual Statement" for 1890-91. The import of foreign coal in 1890 was 784,000 tons; of which the bulk came from England, over 12,000 tons from Japan and 10,000 tons from Australia.

The St. Petersburg International Railway Congress began its work on Aug. 22. About 300 delegates were present; 120 from other countries than Russia.

One effect of the Zone tariff system, says Dr. Weckerle, the Hungarian Minister of Finance, is to entail a very heavy expenditure for extra rolling stock and new stations. He says they want 10,000 new freight cars, 100 locomotives and 500 passenger cars. Including the widening of old tracks and the laying of new ones needed, the estimated total cost of all this is about $15,000,000. In view of this expenditure it would seem that the Zone tariff system is not an unmixed blessing to the Hungarian taxpayer.

Another proposition to furnish electrical power for pumping the water supply of Spokane Falls, Wash., has been made by the Edison Electric Illuminating Co., of that city. The company now offers to furnish the city with electric motive power, delivered to the station, to run its pumps at the rate of $5 per million gallons per day up to 8,000,000 gallons; $4.50 up to 12,000,000 gallons, and $4 for a pumpage above 12,000,000 gallons. The terms of the first offer were given in our issue of Jan. 30, 1892, and were $5 per million gallons for all water pumped or lump sums for periods of five years, advancing in amount with time.

There will be no tower at the World's Columbian Exposition which will approach in height the Eiffel tower notwithstanding the host of schemes for such structures which have been in the air. The tower designed by Mr. Geo. S. Morison, illustrated in our issue of Dec. 5, 1891, seemed to have more chances for actual construction than any other of the proposed structures, but we understand the proposition for the erection of this has been withdrawn.

Soft steel is to a large extent displacing iron in pipe manufacture. The "Iron Age" states that B. F. Sturtevant & Co., of Boston, steam heating engineers and contractors, have ordered nearly 1,500,000 ft. 1-in. steel pipe from the Riverside Iron Works, of Wheeling, W. Va., since the beginning of the year. There is a nut to crack in this for those who think that cutting a thread on steel affects the reliability of the metal more than cutting a thread on wrought iron.

A section of the Amsterdam-Merwede canal has recently been opened to traffic, comprising the part from Amsterdam to Vreeswyk, 28 miles long. The whole canal when complete will have a length of 43.5 miles, running southerly from Amsterdam, and will connect the Merwede, one of the branches of the Maas and Weal delta, with the North Sea canal at Amsterdam. The average width of the canal is 100 ft. approximately with a depth of ten and a half feet. The location of the canal can be seen upon the map of the Zuyder Zee district elsewhere in this issue.

Edison is said to be at work on an incandescent lamp to operate at a higher potential than any now in use,

as high, perhaps, as 200 volts. The great advantage of such a lamp would be the decreased cost of the copper required for the wire circuits. Perhaps a higher efficiency would also be obtained. Incandescent lamps of high potential have been used abroad, we believe, to some extent.

The removal of horse manure from the stables of large cities is a troublesome and expensive matter. Being the manure has been adopted at the stables of Jas. S. Kirk & Co., the Chicago soap manufacturers, and is said to work very successfully. An ordinary hay baling press is used, and the cost of the galvanized wire used for binding is about 2 cents per bale. The baled manure weighs about 20 lbs. per cu. ft., and some 30 or 40 tons can be loaded on a gondola car, whereas loose manure occupies about twice as much space, besides costing more to handle.

The proportion of foreign born inhabitants of the several groups of states is given in Census Bulletin No. 201, as follows:

Per cent. of native born only; not of total.	1870	1880	1890
No. Atlantic (N. E. and Middle).....	25.8	24.1	28.8
No. Central (Ohio to Kans. and Dakota).	21.9	20.2	22.2
Far West (Colorado and W.).....	46.3	39.4	34.2
South Atlantic (including W. Va.).....	2.9	2.8	2.4
South Central (including Tex.).....	3.8	3.2	3.0
Mean for U. S.....	16.9	15.4	17.3

These percentages mean that the number of foreign born has remained nearly constant at 17% of the native born for 20 years, which is equivalent to about 14½% of the total population. Of course, if the children of foreign born parents were also included among foreign born, the percentage would be much larger, but on the other hand, as at least seven-eighths of our immigrants are of the same races as those from which the English race was originally formed, and in about the same proportion, the real effect of the immigration to change the nature of the new American race, now forming, is not great so far. As immigration has been recently running, a much larger proportion of the immigrants are of a quite alien race and civilization, and if it should continue as it has been recently, the effect would be more serious.

The London Metropolitan Tramways Company, in the year ending June 30, 1892, carried 78,642,583 passengers on its 49 miles of line, at an average fare of 2½ cts. per passenger. The Metropolitan Railway (underground), working 52 miles, carried in the same period 87,958,319 passengers, at an average of not quite 3½ cts. per head.

The Directors of the Manchester Ship Canal in their report for the half-year ending June 30, say that they yet need about $7,500,000 to complete the canal to Manchester. This is in addition to the capital already authorized, and new power must be sought from Parliament to raise the sum. As an indication of the volume of tonnage which the ship canal is capable of accommodating, the Directors say that in the six months covered by the report, 10,254 vessels carried 1,057,962 tons on the opened portion. This quantity included 600,000 tons of dredged material. Including the sum of $7,815,360 available, the estimated cost of opening the canal to traffic to Manchester, by Dec. 31, 1893, is $14,136,770. The extra amount asked for includes $1,125,000 for contingencies.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

LAKE ERIE & DETROIT RIVER.—About 28 miles of the extension from Leamington, Ont., east to Merlin, Ont., are now graded, and contracts are being let for 12 miles east from Merlin. The location of the line has been completed to Ridgetown, Ont.

PITTSBURG, OHIO VALLEY & CINCINNATI.—This line from Bellaire to Powhatan, O., will be opened for traffic about Oct. 1, when it is expected the bridge at Powhatan, O., will be completed.

CANADIAN PACIFIC.—A press dispatch from Ottawa, Ont., says: "The Canadian Pacific Railway Company have commenced operations at Renfrew, on the proposed extension to Parry Sound. The work is being carried on by day labor, but this will not be continued long, as the company have called for tenders, and will shortly award the contract. About 50 men are now employed, and it is said that the company is experiencing a little trouble in enlarging their staff in consequence of other railway projects going on in the vicinity. Under these circumstances the work is not being prosecuted on such an extensive scale as desired by the promotors. It is desired to reach Douglas in the course of five weeks, and to complete the work, if possible, as far as Eganville, by Christmas.

IRON RANGE & HURON BAY.—About 18 miles of track have been laid on this line from Huron Bay to Champion, Mich.

FINDLAY, FT. WAYNE & WESTERN.—The contract for this line from the Ohio state line to Ft. Wayne, Ind., 18 miles, has been let to F. B. Douglas. A large force will be put at work at once, and as the work is easy the line will be rapidly built.

SANDUSKY & COLUMBUS SHORT LINE.—About 20 miles of track have been laid on the extension of this line to Columbus, O.; 9 miles south from Bellevue, O., and the remainder north from Marion, O. It is stated that tracklaying will soon begin at Columbus, O.

WILLIAMSPORT & NORTH BRANCH.—The proposed extension of this road, contracts for which have been let to E. J. Gaynor, Son & Co., of Pottsville, Pa., as noted in our issue of Aug. 25, will be from Nordmont, Pa., to Dohm's Summit, on the Lehigh Valley R. R., 17.67 miles.

NEW YORK & NEW ENGLAND.—A press dispatch says that the contracts for the 7-mile extension from Pascong to East Thompson, R. I., have been let, the work to be completed by Jan. 1, 1893.

GEORGES VALLEY.—Jas. Mitchell, West Warren, Me., Contr., writes that the surveys are now in progress for this road from West Warren, Me., through Union, Union Common and South Union, Me., and that three miles to some large lime kilns will be built at once. The remainder of the line will be built next summer. Pres., I. C. Thurston, South Union; Ch. Engr., Wm. Lee, Bucksport, Me.

PHILADELPHIA & FRANKFORT.—A correspondent informs us that this line and the Olney Connecting Ry., in Philadelphia, Pa., will together be 5 miles long. The contractors are John Shields, of Flemington, N. J., and Nolan Bros., of Reading, Pa. There are about 400,000 cu. yds. of earthwork and 30,000 cu. yds. of masonry. The Olney Connecting will be double tracked. It is expected to have the road completed this year.

Projects and Surveys.

COBOURG, NORTHUMBERLAND & PACIFIC.—A correspondent writes us as follows concerning the statement that the contract for building 50 miles of this line from Cobourg, Ont., northwest, had been let to Ferris & Richards, New York City: "I believe that the note in your issue of Aug. 18 to be substantially correct, although all negotiations have been carried on at second hand, and the names of the contractors have never been officially made known. The terms of the contract have all been arranged, and it will be signed as soon as additional aid to the amount of $20,000 has been voted by the municipalities interested, which have yet given no aid. The road is to be built to the Canadian Pacific Ry. standard; maximum grade, 1%, and maximum curve, 6°. The work is mostly light or moderate, with only one large bridge across the Trent River, at Campbellford, Ont. The most interesting feature of the location is the continuous 1% grade from Cobourg to the summit, 13.5 miles, with a total rise of 700 ft. The line will constitute an important feeder to the Canadian Pacific Ry., and affords an outlet to Lake Ontario for the iron ores of the Marmora district. Should the bonus by laws be passed, the location of the line will be started immediately.

PHILADELPHIA & NEW ENGLAND.—A corps of engineers, under the direction of W. H. Tinsman, has been organized to survey this line from Stroudsburg to Port Jervis, N. Y., 42 miles.

Southern.—Existing Roads.

MACON, DUBLIN & SAVANNAH.—The local papers state that this company has "broken dirt" on its proposed extension from Dublin to Savannah, Ga., about 110 miles.

SOUTH BOUND.—Ch. Engr. Thos. D. Lee, Columbia, S. C., is reported as saying that the surveys for the extension to Jacksonville, Fla., will be pushed as rapidly as possible, and that it is expected that the contracts for the section from Savannah to Jamaica, Ga., will let about Nov. 1. The line starts from the junction of the South Bound R. R., and Central R. R. of Georgia, about four miles from Savannah, and will run southwest to Way's Station and Jamaica, passing to the west of Darien and St. Mary's, and thence to a point on Hart's road, about 25 miles from Jacksonville.

NASHVILLE, CHATTANOOGA & ST. LOUIS.—Grading on the extension from Huntsville, Ala., to Hobb's Island, 14 miles, is nearly completed, and tracklaying was begun Sept. 1.

PIEDMONT, LANEY & BIRMINGHAM.—It is announced that this company has completed financial arrangements for the construction of its line. J. C. Laney, Laney, Ala.

JELLICO & BIRD EYE.—Ch. Engr. W. C. Crozer writes us as follows: "On Aug. 27 the contract for grading, masonry, cross-ties, etc., on 7½ miles of the Jellico & Bird Eye R. R., in Whitley Co., Ky., was awarded to the Chattanooga Construction Co. C. E. Danforth Prest. The Jellico & Bird Eye Coal Co. will receive proposals for 60-lb. steel rails, fastenings, spikes, etc., and for a locomotive with hauling capacity of 20 loaded cars, 25 tons each, up grade of 1½%. They will also purchase complete outfit for a coal mine of 1,000 tons daily capacity, such as track and tipple scales, bank-cars, tank-rails, 12 and 16 lbs., iron or steel, office fixtures, etc. E. T. Halsey is Prest.; W. L. Halsey, Secy.; Columbia Finance & Trust Co., Treas., all of Louisville, Ky.

TENNESSEE MIDLAND.—This company has submitted a proposition to Davidson County to extend its road from Perryville to Nashville, on condition that the county subscribes for $350,000 of its stock. The road is to be completed and in operation by Dec. 25, 1893, at which time the subscription is payable. The County Clerk will, on Sept. 12, consider the advisability of submitting the question to the votors.

Projects and Surveys.

PENSACOLA NORTHERN.—This company has been organized to build a railway from Pensacola, Fla., northwest. The officers are Pres., Henry McLaughlin; Vice-Pres., L. Hilton Green, and Secy. and Treas., C. H. Disman. It is stated that the Pensacola & Perdido R. R., running from Pensacola to Milliview, Fla., 9 miles, has been secured by the company and will form part of its line.

PORTSMOUTH PARK DEVELOPMENT CO.—This company is reported to be surveying a railway from Portsmouth to Gilmerton, Va., upon which construction is to begin as soon as the right of way is obtained.

MONTGOMERY, HAYNEVILLE & CAMDEN.—It is announced that the contract for ten miles of this line has been let to Adams & Pruitt, of Birmingham, Ala. Work is to begin as soon as a certain amount of the subscriptions are paid in. S. D. Block, Camden, Ala., Pres.

MISSOURI, EAST TENNESSEE & VIRGINIA.—The "Manufacturers' Record" says: "It is announced that the Missouri, East Tennessee & Virginia R. R. Co. has awarded contract to A. L. & J. H. Conners & Co. to build its road from Perryville to Newport, and a branch road from Linden, Tenn., to Florence, Ala. The contractors are to locate the line, obtain right of way and build a standard gage road, using 65-lb. steel rails, and to construct all spans of bridges 150 ft. in length of iron or steel. They are also to erect all stations, and build a telegraph line along the route. The entire line is to be completed within eighteen months. The railroad company, it is asserted, will use the Tennessee Midland R. R. tracks from Perryville to Memphis, and the Memphis & Little Rock R. R. to Little Rock, from which point it will build a road to Hot Springs and Paris, Tex. The office of the company is 258 Washington St., Boston, Mass."

BRUNSWICK, LA GRANGE & NORTHWESTERN.—It is announced that capital will be forthcoming to build this road as soon as the surveys are made. Jas. H. Fannin, of Atlanta, Ga., is now endeavoring to secure the money necessary to make the surveys.

Northwest.—Existing Roads.

CHICAGO, BURLINGTON & NORTHERN.—Surveys have been completed for a branch to Hanover, Ill., three miles long.

DAKOTA, WYOMING & MISSOURI RIVER.—Track material has, it is stated, arrived for five miles of this line from Rapid City, S. Dak., west, and the rails are now being laid.

LA SALLE & BUREAU CO.—This railway connecting La Salle, Ill., with the Chicago, Burlington & Quincy R. R., and the Chicago & Northwestern Ry., at their crossing in Bureau Co., Ill., has been completed. Pres., E. C. Hegeler; Secy., I. Weerts, and Ch. Engr., L. A. Nichols, all of La Salle, Ill.

Projects and Surveys.

YANKTON, KEARNEY & SOUTHWESTERN.—A project to construct a railway from Sioux Falls, S. Dak., via Yankton, S. Dak., to Kearney, Neb., about 200 miles, is being agitated. N. G. Hand, Kearney, Neb., is interested.

SIOUX FALLS WESTERN.—Pres. Melvin Grigsby, Sioux Falls, S. Dak., writes us that surveys will begin at once for this line from Sioux Falls to Yankton, S. Dak., about 70 miles, and that contracts for its construction will be let during September. The work will average from 16,000 to 20,000 cu. yds. per mile, with a maximum grade of 30 ft. per mile and a maximum curve of 6°. Ch. Engr., D. C. Rice, Sioux Falls, S. Dak.

Southwest.—Existing Roads.

MISSOURI, KANSAS & TEXAS.—The surveys for the extension from Boggy Tank, Tex., to Houston, Tex., about 80 miles, is nearly completed and the contract for construction has been let to Burkitt, Burns & Co.

Projects and Surveys.

KANSAS CITY, ARKANSAS & NEW ORLEANS.—This company, which was chartered some years ago to build a railway from Beebe, Ark., to Monroe, La., with a branch to Pine Bluff, Ark., a total distance of 230 miles, will, it is stated, soon begin work on the section between Hazen and Stuttgart, Ark. Geo. H. Foster, of Beebe, Ark., can give information.

ARKANSAS SOUTHERN.—This company has been chartered in Arkansas to build a railway from Eldorado, Ark., south through Union Co., 13 miles. The officers are Pres., C. C. Henderson, Arkadelphia, Ark.; Vice-Pres., Jesse B. Moore, Eldorado, Ark.; Secy., D. E. Armstrong, Eldorado, Ark., and Treas., Jesse C. Cargile, Eldorado, Ark.

OMAHA & SOUTH TEXAS LAND CO.—This company is pushing a project to build a railway from Houston Heights to connect with the various railways entering Houston, Tex. It will be about 3 miles long.

CLAYTON & PEA RIDGE RY. COAL CO.—This company has been chartered in Illinois to build a railway from Clayton, Ill., through Pea Ridge township, Brown Co., to a point in Schuyler Co. Among the incorporators are Thos. J. Clark, of Pea Ridge, Ill., D. M. Halstead, Keithsburg, Ill., and C. A. Weaver, of Clayton, Ill.

NATCHEZ, ALEXANDRIA & TEXAS.—Chartered in Louisiana to build a railway from Natchez, Miss., southwest to a point in Jasper Co., Tex. The officers are Pres., Chas. E. Roberts; Vice-Pres., J. G. White; Secy., R. W. Brighurst, and Treas., Geo. A. Roberts, all of Alexandria, La.

CALLAO & SOUTHWESTERN.—This company has been chartered in Missouri to build a railway three miles long in Macon Co., Mo. Among the incorporators are Jas. Miller, Sioux City, Ia., and Harry G. Earl and Chas. H. Marmaduke, Callao, Mo.

LITTLE ROCK & HOT SPRINGS.—Chartered in Arkansas to build a railway from Little Rock, Ark., to Hot Springs, Ark., 60 miles. The officers and directors are: Pres., Zeb. Ward, of Little Rock; Secy., S. H. Stitt, Hot Springs; Treas., H. M. Rector, Jr., Hot Springs, and E. W. Kimball and Zeb Ward, Jr.

HOT SPRINGS & MT. VALLEY.—Chartered in Arkansas to build a railway from Hot Springs to Mountain Valley, Ark. The incorporators are the same as for the Little Rock & Hot Springs Ry. Co., noted above.

Rocky Mt. and Pacific.—Existing Roads.

GREAT NORTHERN.—Ch. Engr. E. H. Beckler is quoted as follows in regard to the progress of work on the Pacific Extension of this road: "If good weather continues for 60 days more we can finish the grading in that time. Our forces are all concentrated on the part of the line between Columbia River and the Sound. We are hurrying the earth work, particularly in wet, swampy places, in order to get it done before the rainy weather sets in. We can make rock cuts as easily in wet weather as in dry, so that it is not so urgent to get through with them in this weather. We are building the bridges ahead of the tracklaying, so that there will be no cause of delay. There are three sawmills on this side of the mountains cutting timbers for them. There are 19 bridges in the last 20 miles west of the summit and 16 important bridges between there and Snohomish. This is a larger number than on any other part of the line, but it is not excessive, and there are only two high ones. On the east side the line down Nason Creek is very free from bridges. There are four across the Wenatchee and three above there, from Nason Creek down. The Columbia River bridge is being built in the East, but nothing is being done on the site of it, because we shall have no occasion to use it until the line is through. Construction trains will cross on the transfer boat. About 55 miles of grading from Lowell, Wash., eastward, is now ready for track and we may, with good weather, get the line connected through in three months. The switchback over the summit is now being built. It will run to and fro on the same side hill, with six parallel tracks from the

tunnel over the summit on the west side and with three parallel tracks on the east side. It is not exactly built on timbers, for we cut into the mountain for half the bank and throw the dirt on the outside to make the other half. Then we hold it up with timbers, on the outside.

COLORADO MIDLAND.—Dispatches state that the contract for constructing the Cripple Creek branch has been signed by the officers of this company.

NORTHERN PACIFIC.—This company will reline the Mullan tunnel, Idaho, with brick arches and stone masonry walls. The tunnel is about 3,700 ft. long.

ARCATA & MAD RIVER.—The work on the extension of this California railway up the Mad River is making good progress.

SPOKANE FALLS & NORTHERN.—In regard to the extension of this railway and the construction of the Nelson & Fort Sheppard Ry., D. C. Corbin is quoted by the Spokane "Sportsman" as saying: "I shall not build any railway this year. Next year the Spokane & Northern will be extended to the international boundary, there to connect with the Nelson & Fort Sheppard. It is ten miles from our terminus to the boundary, 60 miles from there to Nelson, 25 miles further to Ainsworth and 12 miles more to Kaslo. The Fort Sheppard road will go up the east side of the Columbia River, opposite to the fort, which is on the west bank of the river. There are several surveying parties at present in the field, and we shall begin work early in the season and complete the line as rapidly as possible."

Mr. Corbin also says that there is no truth in the story that the Canadian Pacific Ry. owns any interest in this road. The road is an independent enterprise.

CERILLOS COAL.—A correspondent writes us as follows: "The Cerillos Coal R. R. is being built from Waldo, on the main line of Atchison, Topeka & Santa Fe R. R., to the coalbanks about 6 miles south of there. There will be about 8 miles of main line and 7 miles of spurs and yard tracks. A large coke oven plant is being built at Waldo, with a capacity for 400 ovens if needed. The coal to be mined is a very fine grade of anthracite with bituminous and coking coal. The estimated total output is 250 cars a day. The road has 3% grades and 15° curves, and is standard gage.

Projects and Surveys.

WEISER & NORTHERN.—Chartered in Idaho to build a railway from Weiser, Idaho, to the Seven Devils mining region, a distance of 90 miles.

ALBANY & ASTORIA.—A press dispatch from Albany, Ore., dated Aug. 27, says: "Work on the Albany & Astoria R. R., projected a year ago, will be taken up at once. Captain E. J. Lanning, Pres.; W. B. Barr, Ch. Engr., and Goerge Humphrey, Atty. of the company, leave tomorrow morning on a tour over the surveyed route of the proposed road between this city and Tillamook to secure right of way for the road and will probably be gone several weeks. They will drive across the mountains to Tillamook, following the line of the road as near as possible. The company has already spent several thousand dollars in making the survey. The company comprises several of Albany's wealthiest business men."

ELECTRIC RAILWAYS.

ATTLEBORO, MASS.—The A. N. & W. Electric Street Railway Co. has been granted the right to extend its tracks to South Main St. to the Seekonk line.

EASTON, PA.—The contract to build the Easton, South Easton & Phillipsburg Electric Railway, now consolidated, and called the Easton Transit Co., has been awarded to Pepper & Register, Philadelphia.

PHILADELPHIA, PA.—The Fairmount Park & Haddington Passenger Railway Co. has been incorporated by Jas. Jarden, Jr., Chas. F. Trego, and others, to construct and operate an electric railway.

NEW ORLEANS, LA.—The City Council is considering an ordinance authorizing the Comptroller to sell at public auction an extension of the franchises of the New Orleans City & Lake Railroad Co., for 25 years from the date of the expiration of the present franchise.

PORTSMOUTH, O.—The City Clerk will receive bids until Sept. 21 for the privilege of constructing and operating a street railroad by electricity or any other improved system of motive power that may come into use, for a period of 25 yrs.

MILWAUKEE, WIS.—The Milwaukee Street Railway Co. has received 30 new electric cars, and 40 more are expected soon. A contract has been awarded to the Filer-Stowell Co. for two triple-expansion engines, 200 HP. each. The property owners of Lake, along the proposed Howell road extension, have raised a bonus of $30,000 for the company, and it is thought a franchise will be granted.

CARTERSVILLE, MO.—The South Missouri Electric Railway Co. has been incorporated by Wm. Donaldson, E. Z. Wallower, and others; capital, $500,000.

OAKLAND, CAL.—The Oakland, San Leandro & Haywards Electric Railway Co. has awarded a contract to the Risdon Iron Works for a 500-HP. Ball engine and Heine boiler. The company has been granted permission to lay double tracks in several additional streets.

ELEVATED AND TRAMWAY RAILWAYS.

CHICAGO, ILL.—The Chicago Merchants' Elevated Railway Co. has been incorporated by Samual A. Craig, E. F. Thompson, and others; capital, $5,000,000.

PITTSBURG, PA.—The Tramway Railway Co. has been incorporated under the laws of West Virginia, by Chas. H. Read, G. C. Read, H. C. Morrison, and others; capital, $1,000,000.

HIGHWAYS.

CALIFORNIA.—It is proposed to build a new and almost air-line boulevard between Santa Rosa and Petaluma, a distance of seven miles. The proposed route is over the Cotati rancho, at Penn's Grove, owned by Wilfred Page, who is especially interested in the proposed boulevard.

WATER-WORKS.

New England.

ALTON, ME.—The Alton & Alton Bay Water Co. has been incorporated at Portland; capital, $50,000; Pres., F. J. Cushing, Lynn, Mass.; Treas., Chas. H. Downing. A reservoir will be built and water will be supplied to the camp ground and to Alton.

MARLBOROUGH, MASS.—The contract for a 2,500,000-gallon pumping engine has been given to H. R. Worthington, New York, for $16,500. The engine will be of the high duty type, and will work against a total head of 408 ft.

NORTH ATTLEBOROUGH, MASS.—It is reported that $50,000 will be used for main extensions.

Middle.

ALBANY, N. Y.—It is reported that surveys and gagings of the Kinderhook Creek, about 22 miles east of Albany, are being made to determine its availability for a new supply.

FAYETTEVILLE, N. Y.—The contract for constructing complete works has been awarded to M. B. Birdseye, who will use pipe furnished by Chas. Millar & Son, Utica. Price for works, $26,357.

FORT EDWARD, N. Y.—At an informal vote on Sept. 31, the people voted 158 to 72 in favor of works, and 163 to 33 in favor of village ownership. An estimate of cost will be secured by the village trustees, and a formal vote taken later. Small private works are in use.

LOWVILLE, N. Y.—Surveys for works have been completed. Village ownership is proposed.

PORTLAND, N. Y.—A company has been formed with F. E. Ryckman, Pres., F. W. Fuller, Secy., and R. A. Hall, Treas. The proposed supply is from springs and from the West Branch of Slippery Rock Creek.

WEST ORANGE, N. J.—It is reported that a franchise has been granted to the Montclair Water Co., of Montclair.

McSHERRYSTOWN, PA.—Subscriptions to the capital stock of proposed company are being obtained.

MARIETTA, PA.—Bids for building works are wanted until Sept. 15, as stated in our advertising columns.

MONTROSE, PA.—The Consumers' Water Co. has been incorporated; $40,000; Treas. Sydney W. Cook, Jermyn.

PHILADELPHIA, PA.—Councils have passed an ordinance authorizing a $1,000,000 loan, for a reservoir in the 28th Ward. Two 20,000,000 or 30,000,000-gallon pumping engines have been recommended for the Spring Garden Station, to pump to the East Park reservoir, at an estimated expense, with boilers, building and inlet, of $250,000. A new pumping station near the Falls is recommended to supply the Queen Lane reservoir, bids for which were to be received Sept. 6; estimated cost, $400,000. The introduction of meters has been recommended.

TIONESTA, PA.—It is reported that the citizens have subscribed $5,000 toward works.

CUMBERLAND, MD.—At the special election, Aug. 29, the people voted against the proposed $100,000 loan for a new supply, apparently because the source had not been determined. It is probable that another vote will be taken soon.

Southern.

ATHENS, GA.—Sept. 30, a second vote on the issuance of bonds for works will be taken. Last spring $125,000 of bonds were voted, but the election was not legal. A company now supplies the city.

TITUSVILLE, FLA.—Works are projected. A 160-ft. well has been sunk with success on some club property.

North Central.

CLEVELAND, O.—Bids for a smoke consuming device for the new boiler house are as follows: Brightman Furnace Co., Cleveland, $3,930; Murphy Furnace Co., Detroit, $5,575; Hawley Furnace Co., Chicago, $6,214.

GREENVILLE, O.—The people have voted 564 to 181 for works. It is said that $80,000 of bonds will be issued. Population in 1890, 5,473.

LINWOOD, O.—Works are talked of.

WILLOUGHBY, O.—It is stated that a contract for $30,000 works has been let to I. W. Newcomer.

EDINBURG, IND.—The people have voted 303 to 68 for works.

LIBERTY, IND.—Small works are talked.

GRAND RAPIDS, MICH.—The Water Committee is still investigating an improved supply. The New York Filter Co. and the Cook Well Co. have each offered to solve the question.

GLENCOE, ILL.—L. H. Cox, John L. Day and others are on the committee which is investigating the question of a water supply. A pump to supply water from the lake is spoken of. The Hygeia Co. have been granted the privilege of laying a 12-in. main in the village. Water is now drawn in carts from the lake to the bluff.

ROODHOUSE, ILL.—The "Eye" says works are needed.

WILMETTE, ILL.—The Water-Works Trustees have adopted the Eddy hydrant for the new works. More than 200 will be used.

NEENAH, WIS.—It is reported that the contract for works has been let to E. T. Sykes, Minneapolis.

WHITEFISH BAY, WIS.—It is expected that works will be built this fall, with a supply from springs.

Northwestern.

LE MARS, IA.—Works are again projected.

PANORA, IA.—Bids for material and constructing works will be opened Sept. 15. There will be a well 12 ft. in diameter and 16 ft. deep; 750,000-gallon duplex pump; 60-HP. boiler; 18 × 24-ft. wooden tank on an 80-ft. wooden tower; 3,100 ft. of 6-in. and 480 ft. of 4-in. cast iron pipe; seven hydrants, and two 6-in. and two 4-in. valves with cast iron boxes. G. M. Reynolds, Mayor; E. B. Haden, Recorder; Chas. F. Loweth, Engr., Drake Block, St. Paul, Minn.

MILES CITY, MONT.—The Water & Electric Light Co., of Miles City, has been incorporated; $50,000; E. R. Gillman, Berthold Ulman and others.

Southwestern.

GUTHRIE, OKLA.—The contract for works has been awarded to Edmund T. Sykes, for $40,889, the extent of the works having been reduced somewhat.

Pacific.

TACOMA, WASH.—It is reported that Nelson Bennett has offered to introduce a new supply from the Mashel River, by gravity, for $2,000,000, taking his pay in 5% 50-year bonds.

LOS ANGELES, CAL.—Cy. Engr. Dockweiler has reported in favor of the city building at an estimated cost of $526,000, the headworks, conduits, reservoirs and pumping plant to be large enough to supply the whole city, but distributing mains to be laid at present, only in the elevated districts of West and East Los Angeles. A special election will probably be held to vote on issuing bonds for the works.

ONTARIO, CAL.—The Nemaha Water Co. has been incorporated; $24,000; directors, J. T. Brady, F. M. Hewitt and others.

BOUNTIFUL, UTAH.—The Bountiful Water Co. has been incorporated to build a reservoir, distribute water, cultivate fish, harvest ice and furnish water power. The principal office will be at Salt Lake City. Incorporators, E. L. and L. R. Pratt, S. J. Ayer, M. G. Cochrane and others.

IRRIGATION.

MENARDVILLE, TEX.—It is reported that a company has been formed to dig a ditch on the north side of the San Saba River.

ROCK ISLAND, WASH.—The Wenatchee Irrigation District, organized a short time ago, is trying to raise money to begin its works, which will ultimately water about 18,000 acres, as reported. Chas. B. Reed, Pres.; Wm. J. Bowen, Secy.

ANAHEIM, CAL.—The Anaheim Irrigation District wish to sell $300,000 of bonds.

KNIGHTS' FERRY, CAL.—E. Armstrong and H. T. Compton, of Stockton, are interested in a scheme to take water from the Stanislaus River near this place.

WINCHESTER, CAL.—Bids for $180,500 of the bonds of the San Jacinto and Pleasant Valley Irrigation District, are wanted until Sept. 20. Pres., W. M. Casterline; Secy., F. T. Lindenberger.

NEW COMPANIES.—Surprise Ditch Co., Corvallis, Mont.: $30,000; J. L. Humbly, J. B. Shaw and others. Bear Creek Reservoir Co., Gallatin Co., Mont.; $12,000; Isaac Williams, Thos. Burke and others. Lima Reservoir & Irrigation Co., Lima, Mont.; $100,000; Pres., J. H. Holmes, Ogden, Utah.; Secy. and Treas., F. S. Avery, Mason, Mich.; Engrs., W. M. Bastaph. Work has been started with Chas. Canfield as contractor. Lake Irrigation Co., Wenatchee, Wash.; $10,000. Summit Lake Canal Co., San Francisco, Cal.; $5,000,000.

SEWERS.

CORTLAND, N. Y.—The contract for making preliminary surveys and plans for the proposed system of sewers has been awarded to W. B. Landreth, Schenectady.

FLUSHING, N. Y.—The Water Committee will receive bids until Sept. 20 for a sewer from the pumping station at Bayside to Little Neck Creek.

HOOSICK FALLS, N. Y.—Plans and specifications for a system of sewers have been prepared by J. Leland Fitzgerald, Schenectady. The estimated length is about 13 miles and the cost from $40,814 to $47,000. The smallest pipe is 8-in. and there will be six temporary outlets into the Hoosick River.

PLATTSBURG, N. Y.—The lowest bids for water supply, sewers and roads for the Plattsburg barracks were as follows: S. W. Frescoln, New York, water supply and sewer, $7,400; J. P. Cunningham, Dannemora, $8,785.

CAMDEN, N. J.—A Board of Sewer Commissioners has been appointed, and organized by electing J. G. Dorrance, President, and S. J. Upson, Clerk.

JERSEY CITY, N. J.—The Board of Street Commissioners will receive bids until Sept. 12 for about 1,350 lin. ft. 12-in. pipe and 2,000 lin. ft. 24 to 30-in. brick sewers, 300 cu. yds. rock excavation, 20,000 ft. B. M sheathing, etc.

ORANGE, N. J.—One bid was received for the erection of the pumping-station, Reynolds, Conway & Co., $13,000, and two bids for the pumping engines and machinery, H. B. Merrill, New York, $5,945, and the Deane Steam Pump Co., Holyoke, Mass., $9,808.

WASHINGTON, D. C.—The contract for the new drainage of the capitol has been awarded to the Durham House Drainage Co., New York, and their system will be used. The vertical soil and waste pipes will be of nickel plated brass, requiring 30,000 lbs. of material, and the drains will be of galvanized steel pipe, of which about 30 tons will be used. The company will erect a steam pipe-threading plant on the premises, and have agreed to complete the work in 90 days. Waring, Chapman & Farquhar, New York, are the engineers.

BRIDGEPORT, W. VA.—The citizens have voted to issue bonds for $12,000 to complete the sewerage system.

NATCHEZ, MISS.—The Natchez Water Supply & Sewer Co., of New York City, has been incorporated in West Virginia to construct water and gas works, sewer system, etc., in this city; capital $300,000.

MARION, O.—The lowest bid for 20,532 lin. ft. of 6 to 12-in. sewers and 23,306 lin. ft. of 6-in. subsoil drains was that of Fred Groch, Sandusky, $4,771. Other bids were above $31,000. John W. Hill, Cincinnati, Cons. Engr.

TOLEDO, O.—The City Clerk will receive bids until Sept. 19 for 12 brick sewers, 20 to 36-in. diameter.

INDIANAPOLIS, IND.—The Board of Public Works is preparing new specifications for the trunk sewers, but it has been decided not to begin the construction until early next year.

DANVILLE, ILL.—Bids are asked until Sept. 22 for sewers in sewer district No. 13, according to the plans and specifications prepared by Geo. E. Waring, Jr. W. F. E. Gurley, Cy. Engr.

ROADHOUSE, ILL.—Bids will be received at the office of the County Clerk until Sept. 13 for furnishing and laying 4,500 lin. ft. 15-in. sewerage tile.

WILMETTE, ILL.—The town is about to spend $350,000 on a water and sewer system, plans for both of which have been prepared by Alexander & Hill, Engrs. Concerning the proposed improvements, F. H. Drury, Clk. Village Council, gives us the following information: The contract for the water system has been awarded to I. W. Newcomer, Cleveland, O., at about $125,000, and that for the sewer system to C. T. Bartlett, Evanston, at $219,024. The sewer will be from 9 to 54 ins. in diameter; that above 18 ins. being brick, and the outlet will be into the lake at Forest Ave. The work will be commenced as soon as the assessments are confirmed, and will be continued through the winter with as little delay as possible. It is expected that all will be finished early next summer. The village has also arranged for paving North Ave. (one of the finest avenues), with Trinidad asphalt, and there is a movement on foot, with fair indications of success, to secure an

asphalt boulevard around the entire village, the Sheridan drive forming a part of the system.

WINNETKA, ILL.—We are informed by Walter Crew, Village Engr., that the town has just completed the first contract for sewers, including the outlet, and about three miles of district No. 1. Assessments are now being prepared for the completion of this district, and the construction of sewers in district No. 2, and work will begin in the spring. The combined system is used, and the plans were prepared by W. S. MacHairg, Chicago.

ST. LOUIS, MO.—The contract for repairing the Mill Creek sewer, which was damaged by the recent explosion, has been awarded to Edward Riley, at $27,097.

TREMONT, NEB.—The sewer contract has been awarded to Sholes & Stone, the lowest bidders, at $25,085.

OMAHA, NEB.—The Board of Public Works will receive bids until Sept. 16 for a sewer in sewer district No. 164.

DENVER, COLO.—The Board of Public Works has declared it necessary to expend $600,000 for sewers before paving Capitol Hill. The issue of bonds is proposed.

SEATTLE, WASH.—The Board of Public Works has authorized the clerk to advertise for bids for 2,000 bbls. of Portland cement for the South sewer tunnel.

OAKLAND, CAL.—The City Clerk will receive bids until Sept. 19 for 8 to 20-in. pipe sewers in two streets.

REDLANDS, CAL.—The committee to investigate a plan for an outfall sewer, has reported in favor of extending the sewer one-half mile, and procuring land for a sewer farm. The estimated cost of the extension is $5,700, and it is proposed to procure land under a lease.

SALT LAKE CITY, UTAH.—The City Council has ordered an additional 1½ miles of sewers.

WINNIPEG, MAN.—A contract has been awarded to Kelly Bros. & Co., at $31,910.

STREETS.

BINGHAMTON, N. Y.—The City Clerk will receive bids until Sept. 12 for paving State St. with vitrified re-pressed paving brick.

BUFFALO, N. Y.—The Committee on Streets has recommended that contracts be awarded to the following lowest bidders: Barber Asphalt Paving Co., 7 contracts, $426,690; Buffalo Paving Co., 4 contracts, $56,660; German Rock Asphalt Co., 4 contracts, $41,018; P. B. McNaughton, $8,804.

ROCHESTER, N. Y.—The contract for paving East Main St. with Medina blocks has been awarded to the Albion Stone Co., at $42,903. The estimate was $55,000.

TROY, N. Y.—Contracts for paving six streets with asphalt have been awarded to Patrick McKenna, at about $156,000.——The Board of Contracts will receive bids until Sept. 13 for paving three streets with vitrified fire brick.

WILMERDING, PA.—A special election will be held Sept. 20 to vote on the issue of improvement bonds for $75,000. Arrangements have been made for paving 13 streets.

LOUISVILLE, KY.—The vitrified brick tests have been completed, and seven contracts have been awarded to John Gleason, for paving with Porter brick; and one contract to Mike Gleason for paving with the Cloverport brick.

CINCINNATI, O.—Bids will be received by the Board of Administration until Sept. 13 for paving one street with brick. The contract for paving Vine St. with granite has been awarded to J. McDermott, at $48,900.

GREENVILLE, O.—The Council has voted to macadamize three streets.

NORWOOD, O.—Bids are asked until Sept. 12 for macadamizing two streets, and until Sept. 26 for macadamizing one street, J. M. Harper, Village Engr.

TOLEDO, O.—The City Clerk will receive bids until Sept. 19 for grading and draining three streets.

INDIANAPOLIS, IND.—The Board of Public Works will receive bids until Sept. 12 for graveling Spruce St., and until Sept. 14 for paving New Jersey St. with Trinidad lake asphalt. Several other streets have been ordered paved with asphalt.

WINNETKA, ILL.—Bids will be received until Sept. 18 for 2½ miles of street grading. Walter Crew, Village Engr., informs us that the village is constructing two miles of cement walk, and that these improvements will be quickly followed by others.

OMAHA, NEB.—The City Engineer reports that it will cost $17,500 to pave the Eleventh St. viaduct with creosoted floor planking and blocks, or $12,000 with untreated pine timber and cedar blocks. The amount of material required would be 2,770 sq. ft. paving blocks, 137,115 ft. floor planking, 24,930 ft. guard rail, and 79,776 ft. sidewalk plank. The Board of Public Works will receive bids until Sept. 16 for curbing and paving, each, two contracts.

GALVESTON, TEX.—The Board of Public Works has voted to readvertise for the paving of 36 blocks with creosoted pine blocks.

OAKLAND, CAL.—The City Clerk will receive bids until Sept. 19 for grading, curbing and macadamizing two streets.

ELECTRICAL.

ELMIRA, N. Y.—The Electric Illuminating Co. is building a new plant, and has placed the contract for the iron roofs with the Berlin Iron Bridge Co., East Berlin, Conn. The dynamo room will be 66×177 ft., covered with the Berlin Company's patent anti-condensation corrugated iron roofing, the floor space being controlled by a 10-ton traveling crane. The boiler-room will adjoin the dynamo room, and will be 32×75 ft.

NEW YORK, N. Y.—The Gas Commission has contracted with the Edison Illuminating Co. for 100 arc lights in Fifth Ave., at 25 cts. per light per night, each light to be of 1,000 c. p.

SEA CLIFF, N. Y.—Col. H. M. Kibbee, Brooklyn, has secured a franchise for lighting by electricity this town. Glen Cove, Bayville and Glen Head. A central power house will be erected at Glen Cove with power to furnish 5,000 incandescent lights of 16 c. p. each.

READING, O.—James Cooper, Village Engr., writes us as follows: "The question of erecting a plant for electric lights and water-works has been discussed considerably of late, but no definite action has been taken. The plan which seems to meet with the approbation of the people is to have both plants run by the same power. No contract has been awarded, as the question is to be submitted to a vote of the people at the November election. We intend to erect our own plant."

WILMETTA, ILL.—F. H. Drury, Village Clerk, informs us that an electric light company is endeavoring to secure a franchise in this village.

SHELL LAKE, WIS.—It is claimed that enough subscribers have been secured to insure a plant, and that the plant will be put in at once.

SEATTLE, WASH.—The Seattle Gas & Electric Co. is about to enlarge its plant. A new two-story brick building, 150×75 ft., will be erected. The company now has five 50-arc light dynamos and will increase the plant to seven. A 1,500-light incandescent plant will also be added.

VISALIA, CAL.—The Visalia Gas, Light & Heat Co. has been awarded a contract for 20 lights of 1,200 c. p. each for three years at $10 per light per month, moonlight schedule.

NEW COMPANIES.—Sussex Electric Light, Water & Power Co., Deckertown, N. J.; $7,000; J. D. Simmons, B. N. Decker, H. D. Van Gaasbeek. Fox Chase Electric Light, Heat & Power Co., Fox Chase, Pa.; $25,000; Treas., Kennedy Crossin. Marshfield Water, Electric Light & Power Co., Marshfield, Wis.; $100,000; Treas., W. H. Upham. Mosher Electric Co., Chicago, Ill.; $64,000; J. A. Mosher, J. R. Begg, E. M. McKinney. Piano Electric Light & Power Co., Piano, Ill.; $25,000; E. L. Henning, H. Sears, J. R. Steward.

CONTRACT PRICES.

DAM.—New York, N. Y.—The following bids were opened Aug. 24 by the Aqueduct Commissioners for the construction of the new Croton dam at the Cornell site, a description of which was printed in our issue of June 2. The total bids were as follows: 1. J. S. Coleman, $4,150,573; 2. H. H. Brown, $4,181,464 (same bid submitted June 20); 3. T. J. Sullivan, $4,314,965; 4. John McQuade, $4,463,800; 5. Winston, Crimmins, Washburn & Co., $4,527,769; X., engineer's estimate, $4,574,820. The contract has been awarded to J. S. Coleman. A detailed statement of the bids opened June 20 was given in our issue of July 7.

Items.	Quantities.	(1) Amount.	(1) $	(2) $	(3) $	(4) $	(5) $	X $
Soil, excavated and placed	2,000 cu. yds.	$1,000	.50	.40	1.00	.30	.40	.25
Sodding	10,000 sq. yds.	3,000	.30	.30	.40	.29	.30	.30
Earth excavation	550,000 cu. yds.	335,500	.61	.60	.65	1.10	1.00	.50
Earth excavation in vertical trenches	35,000 cu. yds.	33 250	.95	1.60	.80	2.00	2.50	1.25
Refilling and embankment	200,000 cu. yds.	225.000	.25	.30	.35	.40	.25	.30
Earth hauled, 3 per cent of	150 000 cu. yds.	1,125	.0075	.009	.0105	.012	.0075	.009
Rock excavation	300,000 cu. yds.	585,000	1.95	2.00	1.25	1.10	1.50	1.50
Permanent timber work	200 M. ft. B. M.	8,000	40.00	40.00	60.00	30.00	30.00	40.00
Permanent timber work, tongued and grooved	120 M. ft. B. M.	5,400	45.00	45.00	60.00	33.00	50.00	45.00
Cribwork	8,0 0 cu. yds.	24,000	3.00	2.50	4.00	3.00	2.00	2.50
Portland cement	1,000 barrels	3,000	3.00	3.25	2.50	3.00	3.00	3.00
Concrete (American cement)	10 000 cu. yds.	45,500	4.55	4.65	4.00	4.00	4.50	4.50
Concrete (Portland cement)	3,000 cu. yds.	18,018	6. 06	6.138	5.28	5.28	6.468	5.94
Brick Masonry	2,000 cu. yds.	20,000	10.00	10.50	12.00	15.00	10.00	12.00
Rubble (American cement, 2 to 1)	470,000 cu. yds.	1,993,500	4.05	4.00	4.25	4.00	4.60	5 60
Rubble (American cement, 3 to 1)	30,000 cu. yds	160,385	5.346	5.28	5.61	5 28	6.072	6 60
Rubble (Portland cement, 3 to 1)	50,000 cu. yds.	247,050	4.911	4.88	5.185	4.88	5.612	6.10
Dry Rubble	12,000 cu. yds.	30,000	2.50	2.60	3.00	2.50	2.50	2.50
Rip Rap	5,0 0 cu yds.	8,750	1.75	1.00	2.00	1.70	1.70	1.10
Broken Stone	10,00 cu. yds.	15,000	1.50	1.50	2.00	2.00	1.25	1.50
Block stone masonry	2,500 cu. yds.	37,500	15.00	15.00	4 00	20.00	23.00	15.00
Granite dimension stone masonry	2,500 cu. yds.	87,500	35.00	35.00	50.00	33.00	26.00	30 00
Facing stone masonry	24,000 cu. yds.	324,000	13.50	14.00	15.00	17.00	11.00	15.00
Face work for rubble	15,000 sq. ft.	6,000	.40	.30	2.00	.40	.32	.30
Fine hammered (six-cut) face dressing	22,000 sq. ft.	14,300	.65	2.00	.70	.60	.75	.75
Rough pointed face dressing	12 000 sq. ft.	4,800	.40	.40	1.60	.40	.30	.40
High way fence	8 000 lin. ft.	4,000	.50	3.00	.20	.15	.50	.50

WATER-WORKS.—Willoughby, O.—The contract for a complete plant has been awarded to I. W. Newcomer, at $28,064. The Water-Works Board selected the material to be used, for which bids had been received at the following prices: Lake Shore Foundry, Cleveland, O., pipe, $23 per ton; specials, 2¼ cts. per lb.; Rensselaer Valve Co., Troy, N. Y., 10-in. valves, $25 each; 8-in., $18.20; 6-in., $12.10; 4-in., $7.40; Ludlow Valve Co., Troy, N. Y., hydrarts, without frost case, $22.10; Hughes Steam Pump Co., Cleveland, O., pumps and boilers, compound, $3,800, and compound-condensing, $4,290. J. B. Strawn, Salem, O., is Consulting Engineer.

BREAKWATER.—New Haven, Conn.—The contract for completing the new southwest breakwater has been awarded by Col. D. C. Houston, U. S. Engr., to John Beattie, Lute's Island, at $1.09 per gross ton for granite. The appropriation is $125,000.

STREET WORK.—Lockport, N. Y.—The contract for paving about 14,300 sq. yds. of West Main St. with brick, has been awarded to P. H. Tuohey & Co., at $2.27 per sq. yd., with an allowance of 30 cts. per lin. ft. for curbing.

Terre Haute, Ind.—The contract for paving Seventh St. with asphalt has been awarded to the Warren-Scharf Asphalt Paving Co., at $2.32 and $2.42 per sq. yd., and $2.75 per sq. yd. for repairs for five years.

SEWERS.—Terre Haute, Ind.—Three contracts have been awarded to Wm. F. Mercer, at the following prices: 30-in. brick sewers, $2.75, $3.75 per lin. ft.; 24-in pipe, $2.25; 18-in., $1.10; 15-in., $1.90; cts.; 12-in., 55 to 80 cts.; 10-in., 55 cts.; lamp holes $4 each; manholes, $30; catch-basins, $60.

MISCELLANEOUS.

BUILDING.—Trenton, N. J.—The time for receiving proposals for the state building, to be erected on the grounds of the World's Columbian Exposition, Jackson Park, Chicago, has been extended to Sept. 13. The competition is limited to residents of New Jersey.

New Orleans, La.—B. M. Harrod, Chn. Space and Building Com., La. World's Fair Comrs., has been authorized to solicit bids for the construction of the state building at Jackson Park, Chicago.

New York, N. Y.—The Department of Parks will receive bids until Sept. 14 for alterations and repairs to the Castle Garden building in Battery Park.

DREDGING.—New York, N. Y.—The Department of Docks will receive bids until Sept. 15 for dredging about 89,700 cu. yds.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have built 2 passenger and 5 freight engines, on the Vauclain four-cylinder compound system for the Great Northern. The Illinois Central will place orders for two suburban tank engines, with cylinders 18×24 ins., six driving wheels, a leading two-wheel truck and a trailing six-wheel truck. The Baltimore & Ohio has added 50 locomotives to its equipment this year, including 10 built by the Baldwin Locomotive Works. The Cleveland, Cincinnati, Chicago & St. Louis has ordered 50 locomotives. The Chicago, Milwaukee & St. Paul will build several engines at its shops in Milwaukee, Wis.

CARS.—The Russell Wheel & Foundry Co., Detroit, Mich., is building 125 logging cars for the Brainerd & North Minnesota. The Michigan Car Co., Detroit, Mich., has a number of orders on hand. The Chicago & Northwestern will make extensive additions to its equipment. The Youngstown Car Co., Youngstown, O., is building freight cars for the Pittsburg & Lake Erie.

FENCES.—The Western Fence Co., Chicago, Ill., is building 200 miles of galvanized barbed wire fence for the Burlington, Cedar Rapids & Northern, 250 miles of five wire fence for the Chicago, Rock Island & Pacific through Indian Territory, and has also a contract to build 250 miles of six-wire fence for the Missouri, Kansas & Texas extension from Boonville to St. Louis, Mo.

J. B. CLOW & SON, of Chicago, Ill., have established a pipe foundry for casting water-works pipe and specials, at New Philadelphia, O. This firm has recently secured the agency of the Eddy valves and hydrants, from the Eddy Valve Co., of Waterford, N. Y., formerly held by the Fieldhouse & Dutcher Mfg. Co., and will carry a full line of their goods. They also carry a full line of sanitary supplies.

THE CLARK COUPLER CO. has been incorporated at Chicago, by Jas. J. Flannigan, A. J. Moore and John M. Young.

THE CAR TRUCK SUPPLY CO., of Chicago, has arranged with Frank Bakeman & Co., for the exclusive manufacture and sale of the Schuttler ratchet track drill, described in our issue of June 20, 1891. Although on the market for only one year, this drill has been extensively adopted, being now in use by over 70 railways, besides a large number of street and electric roads. Mr. W. S. Burling is Secy. and Manager of the company.

COMPANIES.—Althouse Automatic Car Coupler Co., Toronto, Ont.; $100,000; J. C. McKeggie, of Toronto; M. J. Althouse, Waupun, Wis. Slocum Engineering & Construction Co., Chicago, Ill.; Thomas S. Slocum, L. Dumas and H. Buerdorf. Pacific Construction Co., San Francisco, Cal.; $250,000; J. P. McCormick, W. T. Kearns and A. J. Meadows.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $18 for iron and $13.50 for steel. Pittsburg: $30; old rails, $19.50 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; old rails, $18 for iron and $14 to 14.50 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.5 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.65 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 60 and 50% on black and galvanized butt-welded; 70 and 60% on black and galvanized lap-welded. Casing 55%.

FOUNDRY PIG IRON.—New York: $13.50 to $15 Pittsburg: $13.25 to $14.75. Chicago: $13.25 to $15.

LEAD.—New York: 4.1 to 4.15 cts.; Chicago: 3.95 to 3.97 cts.; St. Louis: 3.95 to 4 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.9 to 2.1 cts.; steel plates, 1.95 to 2 cts. for tank, 2.2 to 2.25 cts.; for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.05 cts. for large lots, and 2.1 to 2.15 cts. for small lots; channels, 2 to 2.05 for large lots, and 2.1 to 2.15 cts. for small lots; angles, 1.85 to 1.95 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2.1 to 2.15 cts.; universal mill plates, 1.8 to 1.85 cts. for iron and 1.9 to 2 cts. for steel; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.85 to 1.95 cts. for tank, 2 to 2.15 cts. for shell, 2.1 to 2.2 cts. for flange, 3.6 to 3.75 cts. for firebox. Chicago: beams, 2.3 to 2.35 cts. for large lots, and 2.5 cts. for small lots; channels, 2.15 to 2.25 cts.; angles, 2 to 2.15 cts.; tees, 2.25 to 2.4 cts.; universal plates, 2.15 to 2.25 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.15 to 2.4 cts. for shell, 2.6 to 3 cts. for flange.